Since 1964, the leader in effective, safe and reliable products for fisheries conservation.
Knowledgeable biologists depend upon Smith-Root equipment.

USER'S MANUAL
ELECTROFISHING BOATS
for all SRI H and EH Model Electrofishing Boats

SMITH-ROOT, INC.
Technology For Fisheries Conservation

smith-root.com

USER'S MANUAL
ELECTROFISHING BOATS

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Items manufactured by companies other than Smith-Root carry the original manufacturer's warranty. Please contact product manufacturer for return instructions.

All Smith-Root, Inc. manufactured products are covered by a one-year warranty.

Credit & Refund Policy: Customers returning equipment - in new condition - will be given a refund within five days from the date of the return. A return authorization must accompany returns. Valid equipment returns include, but are not limited to, ordering incorrect equipment, funding deficits and defective equipment returned for reimbursement. All returns are subject to a restocking fee and applicable shipping charges. The restocking fee is figured at 10% of the purchase price but not less than $20.00. Customers receiving equipment in damaged condition will be referred to the shipping company for insurance reimbursement.

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ELECTROFISHER BOAT MANUAL

INTRODUCTION

OVERVIEW

All Smith-Root boats are heavy-duty electrofishing work boats designed to provide safe and stable working conditions. They provide the fisheries researcher with the utmost in electrofishing efficiency and equipment reliability. The quality workmanship and attention to detail that go into every Smith-Root electrofishing boat are demonstrated by our ever-growing number of satisfied customers.

The modular design of our boats provide flexibility in use. The forward work deck provides a safe area for netting and other sampling operations. The gunwale top is smooth to prevent abrasion and net snags. Forward work lights illuminate the entire front area of the boat. Stern lights provide illumination to the rear of the boat.

BOAT HULL

The hulls are constructed of a rugged aluminum alloy that gives superior impact strength and excellent resistance to water and weather corrosion. The fabrication features all-welded seams. H models feature hard machine-rivets at all critical rib support points. Seams are double welded at the bottom-to-gunwale sections, providing extreme impact strength. The forward work decking is anti-skid Dri-Dek® mat and the walkways are aluminum treadplate.

Smith-Root H and EH model boats are heavy-duty electrofishing work boats designed to provide the fisheries researcher with the utmost in electrofishing efficiency and equipment reliability.

H model boats feature a sled-style hull, available from 14' to 18' in length, perfect for shallow water fishing operations. For rough water conditions, our EH models offer our rugged modified "V" hull available in 18' to 21' lengths.

All Smith-Root boats come equipped with an extra heavy-duty transom. Transoms are 20”, 25" or 27" high and are built with a double H-frame-style reinforcing. This transom is highly resistant to damage on or off the trailer. Side heights are 24" for the H-series and 30" for the EH-series boats.

RECEIVING & INSPECTION

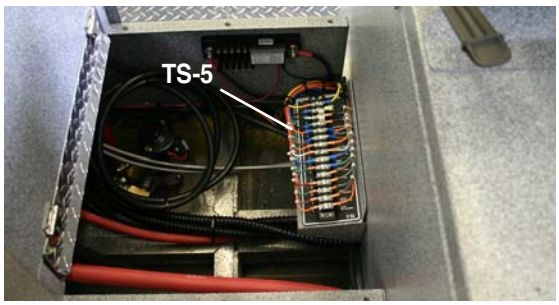
Before using your new electrofishing boat, please read and perform the following procedures.

During shipping it is possible for damage to occur. Also, nuts, bolts, or screws may have vibrated loose.

1. Give your boat a good visual inspection for possible shipping damage.

2. Make sure battery selector switch is OFF.

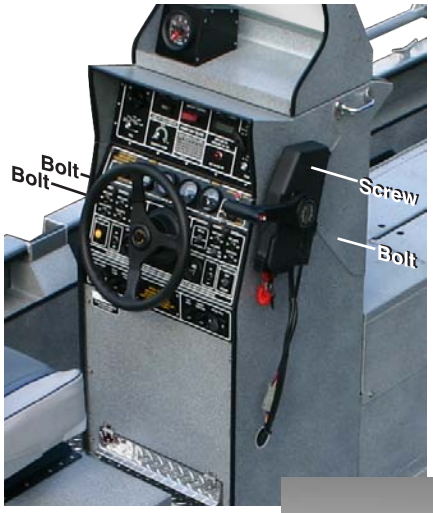
3. Remove the six 1/4-20 bolts holding the pilot deck cover on. The pilot deck is located between the Console and the Generator housing (7/16" wrench required).



Remove the pilot deck cover revealing the TS-5 terminal strip and pump compartment. Remove protective cover over terminal strip.

4. Check all of the screws on the TS-5 terminal strip, pump bases, and boat ground buss bar to make sure that none have vibrated loose (Phillips screwdriver required).

5. After thorough inspection of this area, replace the pilot deck cover and tighten bolts.



6. Inspect the center console. Remove the top mounting Phillips screw from the outboard throttle and gear shift control box. Remove the 1/4-20 bolt in front of the outboard control box on the side of the console. Remove the two 1/4-20 bolts on the other side of the console (Phillips screwdriver and 7/16" wrench are required).

7. Rotate the console forward, resting it on the top of the fish tank lids. Make sure your Battery Selector Switch, located on the port side of steering & control console, is in the "OFF" position.

8. Check all the screws on the terminal strips, used and not used, for tightness. Check all instrument mounting screws and electrical connections. Check all the hardware mounting screws and boat ground buss bar screws (Phillips and flat-blade screwdrivers, 5/16", 3/8", 7/16" and 1/2" wrenches are required).

9. Rotate the console back to its upright position. Re-secure the console fasteners.

10. Open the access hatch on the front of the console (the circuit breaker and patch panel compartment). Visually inspect all the breaker holders for tightness. Close and latch the compartment.

11. Check tightness of all mounting bolts around the fish holding tank, battery compartment, console, pilot deck and generator housing (7/16" wrench is required).

The Control Console is mounted on the central island structure. The electrofisher control panel is mounted at the top of the consoles within comfortable reach of the boat operator. An adjustable audio tone and the high voltage indicator lamp are activated whenever electrofisher output is present. The console also contains a GPP Patch Panel allowing complete selection of anode/cathode boom configurations. Consoles hinge forward to provide easy access to all steering controls, switches, circuit breakers, and wiring terminals for the entire electrical system. All wiring terminals are clearly labeled for easy identification and servicing. A schematic diagram is provided which shows all wiring and terminal designations for the entire boat. Two spare switches and 2 accessory plugs are provided on the console for additional electrical equipment.

Work-Up Lights and 12V Accessory plug

Console Cover provides complete weather protection to the steering and control console. Constructed of heavy duty canvas with reinforced corners. (not shown)

Work-Up Lights are provided on the front of the console, (pictured above). The lights are recessed and aimed to light up the fish tank and not shine in crew member's eyes.

Batteries are housed under fire extinguisher/storage compartment

Outboard controls are mounted on the right side of the control console.

BATTERY AND CHARGING SYSTEMS

All models of boats come with three marine batteries housed in chemical resistant enclosures (two in main compartment, one in enclosure at stern). A 40 amp charging system utilizes

Outboard cranking battery in stowed position at stern

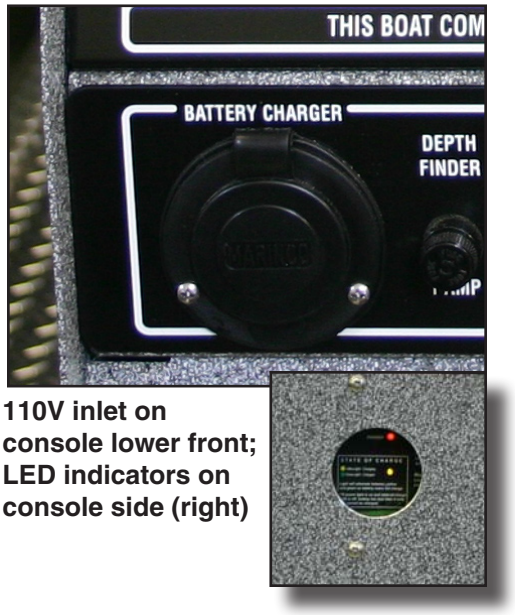
power from the GPP generator. Charging from the outboard motor is also incorporated in the charging system.

The battery compartment provides space for two marine batteries. The Storage compartment above the batteries provide space for a marine fire extinguisher and miscellaneous small items. There is a separate cranking battery for the outboard motor.

CONTROL CONSOLE

BATTERY MAINTENANCE CHARGER

The Battery/Charging system includes a charger that connects to a 110V service (via its receptacle, shown at right) when the boat is not in use for extended periods of time. It automatically brings the battery's level to a full charge and maintains it. LEDs indicate battery charging status (inset).



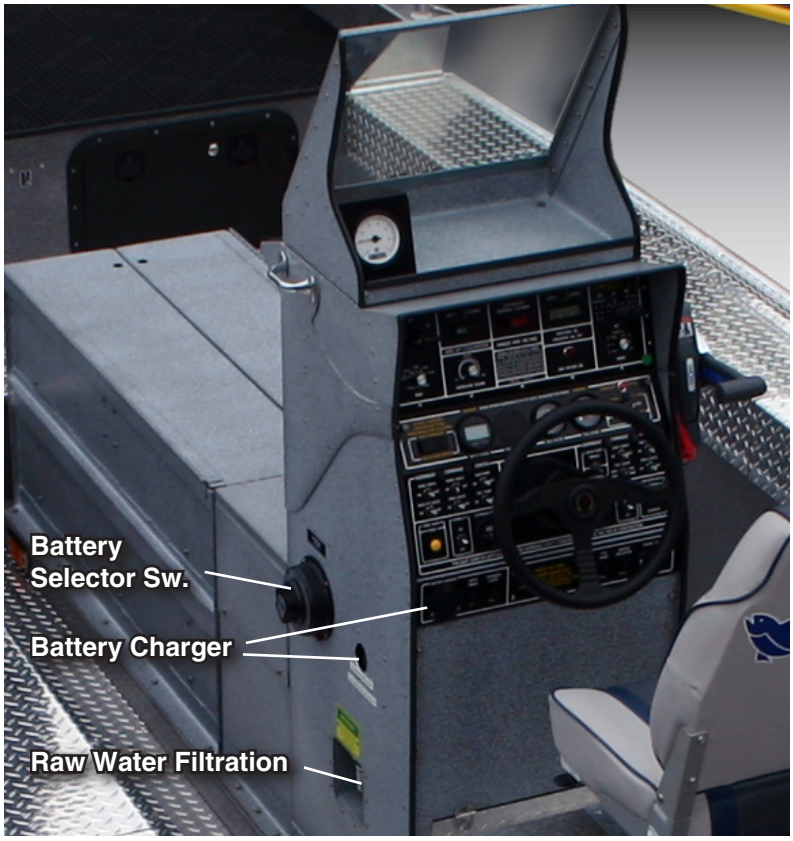
110V inlet on console lower front; LED indicators on console side (right)

BATTERY SELECTOR SWITCH

The Battery Selector Switch is located on the left side of the control console. It allows you to switch between the two separate main batteries, run on both simultaneously or to shut both batteries off when boat is not in use. Switch should be in 'BOTH' position when charging.

GENERATOR RAW WATER FILTRATION

The Generator requires raw water for coolant purposes. The Raw Water Filter located on left side of control console must be inspected daily and any potential obstruction removed in order to prevent damage to the intake system. Bowl is translucent to facilitate inspection.



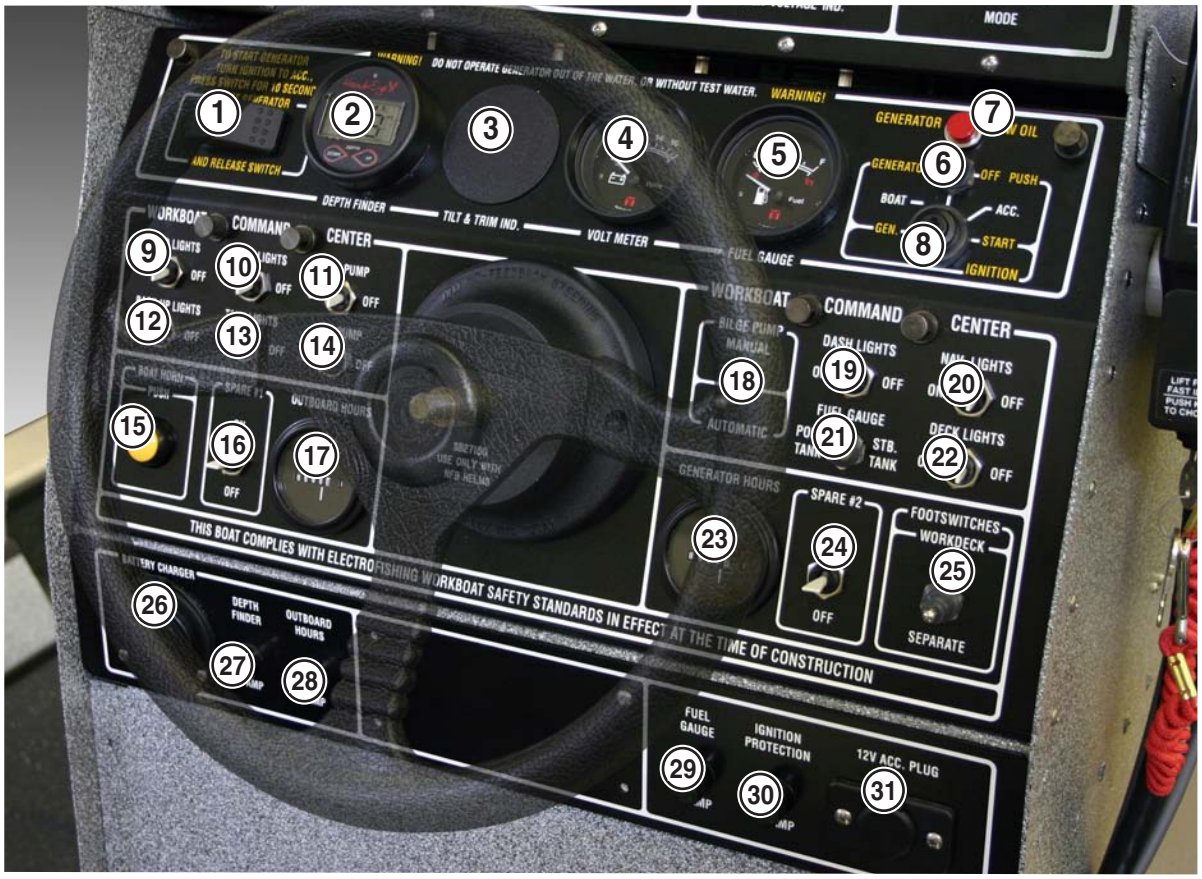
Battery Selector Switch

Generator Raw Water Filter

CONTROL CONSOLE

UPPER PANEL ITEMS

1. **VENTILATION FAN -**cools and clears vapors from generator compartment. Button must be pressed while starting the generator.
2. **DEPTH FINDER** - indicates water depth below boat
3. **TILT & TRIM -** outboard tilt and trim indicator (optional, not shown)
4. **VOLTMETER -** expanded voltmeter 12V system
5. **FUEL GAUGE -** indicates fuel level of selected tank. Outboard powered.
6. **GENERATOR OFF -** kills generator engine with key in “on” position
7. **GENERATOR LOW OIL** - comes on if oil pressure is low
8. **GENERATOR START** - ignition and 12V accessory power



MAIN PANEL CONTROLS

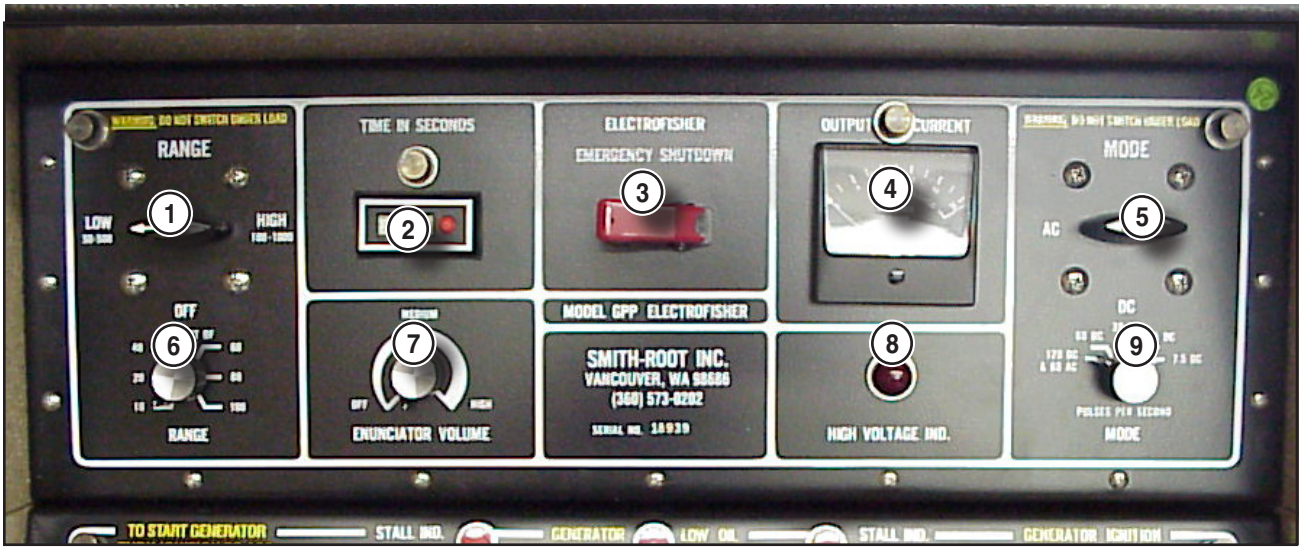
9. **HEADLIGHTS** - illuminates water forward. 12V, generator not required
10. **WORK LIGHTS** - illuminates water around front work deck. Generator powered
11. **TANK PUMP** - fills livewell and provides flow through water system
12. **BACKUP LIGHTS** - illuminates behind boat
13. **TANK LIGHTS** - illuminates fish holding tank
14. **RECIRCULATION PUMP** - water for aeration, can be used on trailer
15. **HORN -** operates loud marine horn
16. **SPARE #1** - For wiring an additonal console accessory
17. **OUTBOARD HOURS** - records outboard total hours
18. **BILGE PUMP -** switches bilge pump from auto to manual
19. **DASH LIGHTS -** illuminates dash panel.
20. **NAVIGATION LIGHTS** - operates Coast Guard approved navigation lights
21. **FUEL GAUGE SWITCH** - toggles between port and starboard tank sender unit. Outboard powered.
22. **DECK LIGHTS -** illuminates walkways and workdeck
23. **GENERATOR HOURS** - records total generator hours
24. **SPARE #2** - for wiring an accessory under the pilot deck
25. **WORKDECK FOOT SWITCH** - allows for and/or operation of foot switches

LOWER PANEL ITEMS

26. **BATTERY CHARGER INPUT** -For connecting 110V service to battery maintenance-charger when not in use
27. **DEPTH FINDER FUSE** - 1 amp
28. **OUTBOARD HOURS METER FUSE** - 5 amp
29. **FUEL GAUGE FUSE** - 5 amp
30. **IGNITION PROTECTION** - 15 amp
31. **12V ACCESSORY PLUG** - For additional electrical equipment

GPP CONTROLS

Inset: Range switch as seen on a 7.5 or 9.0 GPP.



ELECTROFISHER CONTROLS

1. **RANGE SWITCH:** Selects the output voltage range between high and low or switches the output to OFF (**Caution!: The position of this switch should not be changed when current is flowing, i.e. foot switches engaged!**).
2. **TIME IN SECONDS:** Records the actual shocking time. It counts only when high voltage is applied.
3. **EMERGENCY SHUTDOWN:** Provides a local override of remote foot switches.
4. **OUTPUT CURRENT METER:** Shows the current flowing between the anode and cathode in amps and indicates when the RANGE switch should be moved to the LOW position. For 7.5 and 9.0 GPPs, follow the output table.
5. **MODE:** Selects the type of output pulses, AC or DC (**Caution!: The position of this switch should not be changed when current is flowing, i.e. foot switches engaged!**).
6. **PERCENT OF RANGE:** Adjusts the output pulses to a percent of the selected range, i.e. high/low. Pulse width is also automatically adjusted between 6 and 1 millisecond pulse duration.
7. **ENUNCIATOR VOLUME*:** Controls volume of output of warning tone.
8. **HIGH VOLTAGE:** Red indicator lamp shows when voltage is present on output power terminals.
9. **PULSES PER SECOND**: Selects the number of pulses in the output wave form.

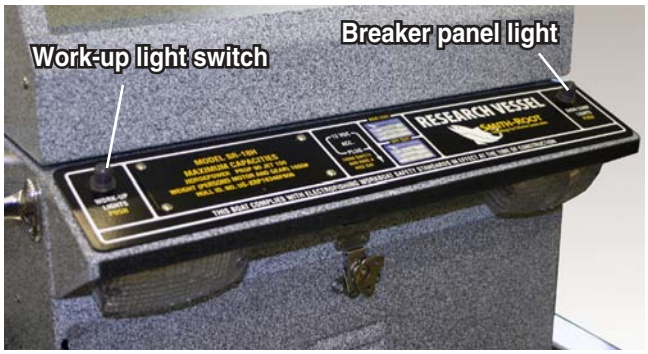
*Enunciator Volume: The Audio Alarm warning tone indicates an output voltage. The control adjusts the volume of the Audio Alarm or turns the Audio Alarm off.

Note: Switch the Range switch to the OFF position when the GPP is not in use. The Audio Alarm warning tone will sound if the generator is running without the electrodes in the water and the switch is not OFF.

GPP PATCH PANEL

On the front of the console is a hinged lid, with corner cutouts for the optional foot switch cables, that houses the GPP Patch Panel. Inside, the GPP Patch Panel consist of four parts:The patch panel, main panel with circuit breakers and auxiliary foot switch/command center.

Work-up lights can be seen above patch panel door.



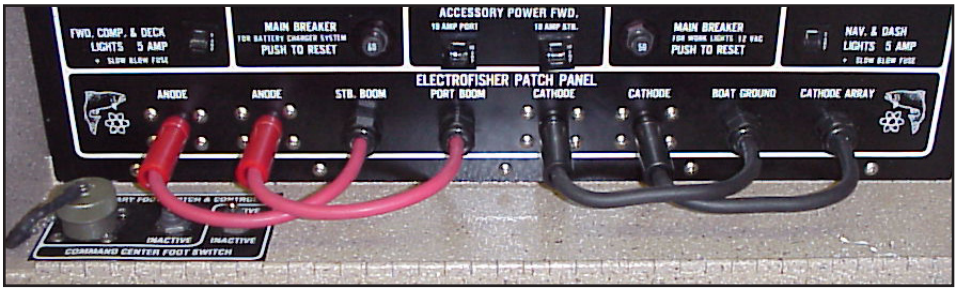
(Above) Work-Up Lights and Patch Panel Light Switches

(Left) Aux. Foot Switch/ Command Center Switch.

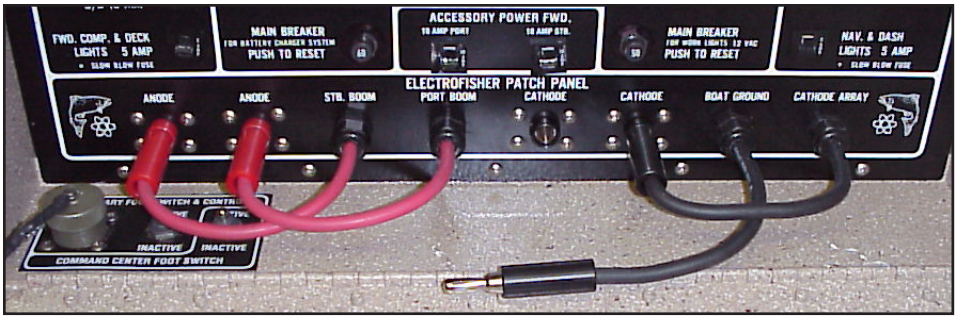
Open door view of Patch Panel and Circuit Breakers.

GPP PATCH PANEL CONFIGURATIONS

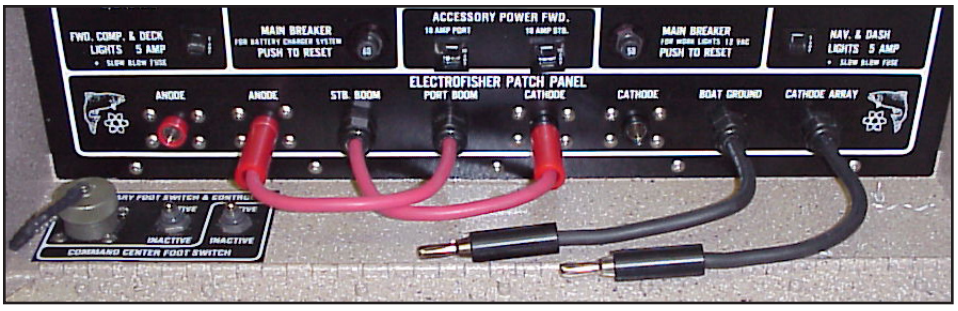
PATCH PANEL CONFIGURATIONS STARTING WITH THE MOST COMMONLY USED.



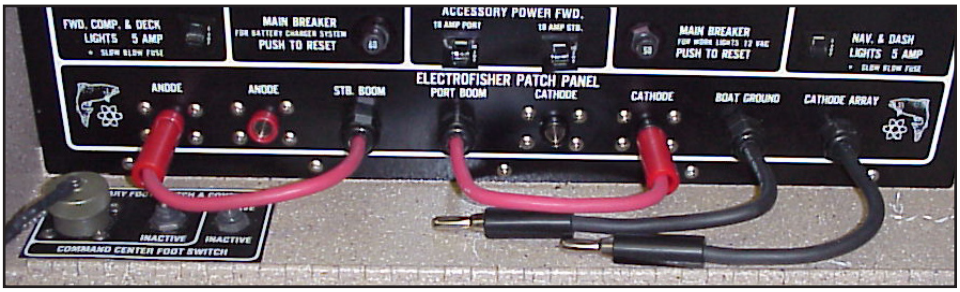
Port and starboard booms as anodes - boat and insulated cathode array as cathode (most common arrangement).



Port and starboard arrays as anodes - insulated cathode array as cathode. Boat ground isolated, required in California and BC.



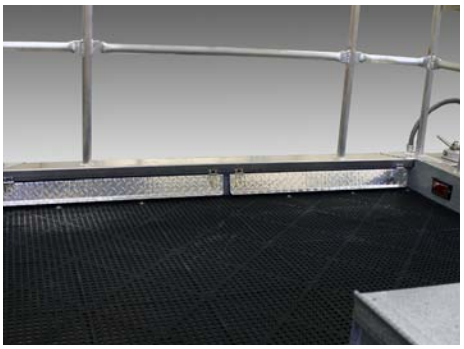
Port boom as anode - starboard boom as cathode - boat hull and cathode array isolated.



Starboard boom as anode - port boom as cathode - boat hull and cathode array isolated.

WORK DECK FOOT SWITCH SETTINGS

The *Both* and *Separate* foot switch position switch is located on the lower starboard side of the console. The switch controls the function of the work deck foot switches. In the separate position, each foot switch controls the output. In the Both position, the two foot switches must be pushed simultaneously to activate output. The Command Center foot switch is located on the aft side of the console and is operated by the helmsman.



Left to Right - *Both* and *Separate* work deck switch on console front; Command Center Foot Switch; Work deck foot switches.

COMMAND CENTER & AUXILIARY FOOT SWITCH SETTINGS

The Patch Panel cables have been unplugged in the following pictures so the Auxiliary Foot Switch & Control panel can be seen.

Note:The Both/Separate switch only affects the work deck foot switches and has no effect on the Auxiliary or Command Center foot switches.

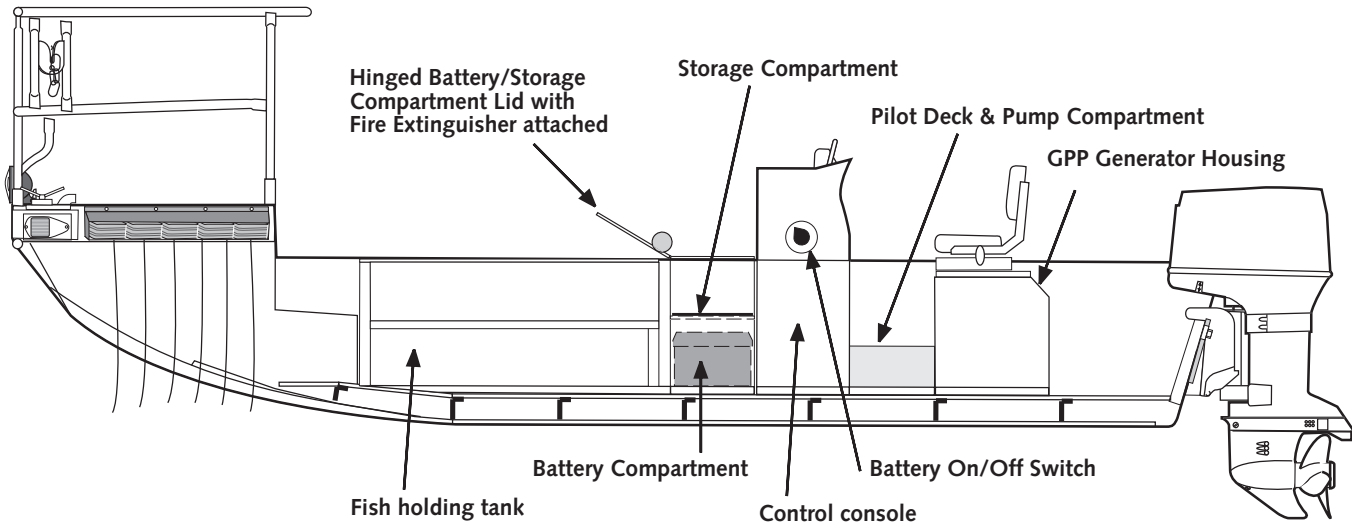
1. Auxiliary foot switch inactive/command center foot switch inactive - (not required, no foot switch plug needed to operate normally). Note: one or both work deck switches must be operated.

2. Operation of command center foot switch required. Operation of auxiliary foot switches not required. Note: one or both work deck switches must be operated. The Command Center (Pilot) foot switch or Auxiliary foot switches will not activate the shocker alone. One of the work deck foot switches must be pushed (separate position).

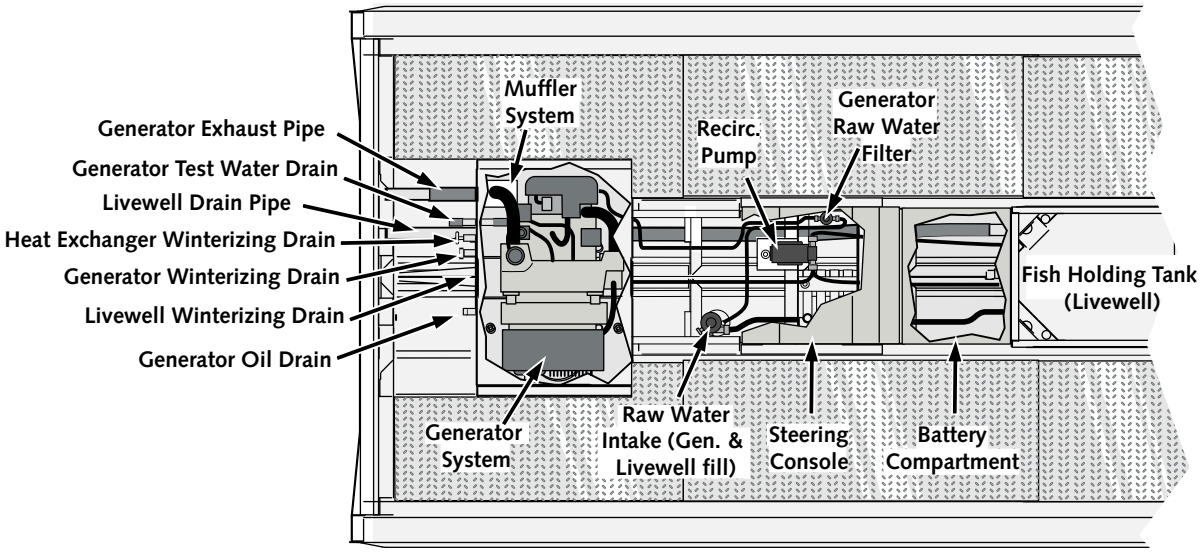
3. When using an auxiliary foot switch, the toggle switch must be in the **active** position. Electrofisher will not operate without auxiliary foot switches depressed. Note: one or both work deck switches must be operated.

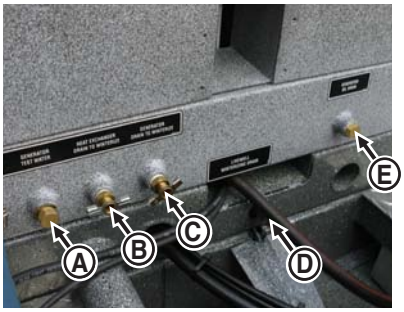
Auxiliary Foot Switch

COMPONENTS & ISLAND LAYOUT



Above - Profile of typical boat, showing arrangement of major components.





Above - Arrangement below island super-structure showing Generator, Battery compartment, pumps, Livewell plumbing and winterizing/maintenance drains.

Right - Drain manifold details:
A- Generator Test Water ; B- Heat Exchanger Winterize Drain; C-Generator Winterize Drain ; D- Livewell Winterize Drain; E- Generator Oil Drain.

PRE-LAUNCH CHECKLIST

1. Check your batteries.

   Note: If the batteries need to be charged, use built in charger.

2. Turn the battery selector switch and boat ignition "On" to test the electrical system.

   Note: DO NOT run pumps without water. The impellers will become damaged very quickly.

3. Check the generator oil level. See Electrofisher section; Generator Owner's Manual for details.

4. Check the outboard oil. See Motor Section - Outboard Owner's Manual for details.

5. Check the generator and outboard motor fuel supply.

6. Check the fire extinguishers. (The gauge should be in the green).

7. Check the fish holding tank for stand-pipes and cleanliness.

8. Check boat for required equipment:
   - Life jackets for all personnel on board, plus one extra
   - Rubber coats, rubber boots, and rain gear
   - Rubber gloves
   - Dip nets
   - Tools
   - Spare bilge plug

9. Be sure to store all personal gear before launching the boat.

10. Locate the bilge plug and install before launching.

11. Give everything one final visual inspection before launching.

ELECTROFISHING BOATS

LAUNCHING INSTRUCTIONS

1. Don't forget to install the Bilge Plug.
   (Oh yes, you will, we all have!)

2. Remove Tie-down strap. Disconnect the trailer lights.

3. DO NOT disconnect your winch line or safety chain until the boat is in the water and outboard is warmed-up.

4. Back the boat into the water.
   "Caution" If your tow-vehicle has an automatic transmission, after starting down the launch, shift your transmission to neutral, and use the weight of the tow-vehicle to launch your boat. Your transmission's pulling backward may cancel out your rear brakes. On a steep, sandy, or slippery launch, your front brakes may be inadequate to stop at the desired launch position.

5. Launch Position. Do not over-launch your boat. Don't back the trailer in over the top of the fenders.

6. Start the outboard and let it warm up on the trailer. While it is warming up, check the Bilge Plug for leakage. Verify outboard motor water pump operation by looking for a steady stream of water coming out to the water pump indicator.

7. After warming up, shift the outboard into forward to hold the boat firmly against the bow receiver. Now have a crewmember unhook the safety chain and winch line. Once the bow is unhooked, shift into reverse and back off the trailer.

8. Loading and unloading your boat at the boat launch can be a tricky situation. Wind and current affect launch conditions severely. It is better to load and unload without additional crewmembers on board. Additional weight and crewmembers moving about in the boat will drastically change low speed maneuverability of the boat.

9. Either beach or dock the boat to load your crewmembers. Before leaving the dock or beach, make sure all hands have put on their personal flotation devices (life jackets). Now you are ready to get underway.

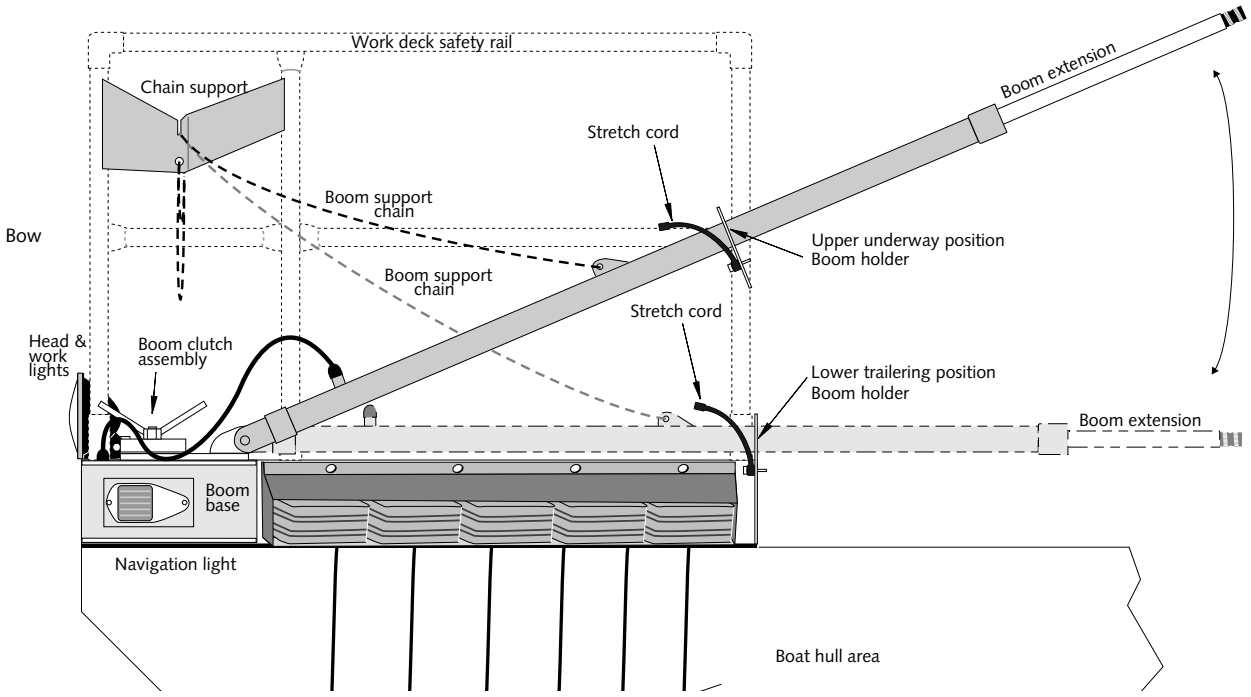
UNDERWAY OPERATING AND ELECTROFISHING PREPARATION

UNDERWAY OPERATING TIPS:

1. Before starting your outboard engine, read the information in the "Motor" section for fuel mixture ratio and break-in procedures. Prior to getting underway, run the outboard at a fast idle for the first 1 1/2 to 2 minutes. This will allow engine to be completely warmed up and will ensure all working parts are well lubricated.
2. During this warm up time, have a crew member move the booms from the lower trailering positions to the upper underway position. When attaching the arrays, attach the safety line first, then connect the quick connector . Do not unfold your arrays at this time.
3. Check your trim. Trim your bow up or down to suit your boat load and water conditions. If your boat wants to porpoise, trim your bow down. *For more information, see "Motor" section.*
4. When you reach the job site, throttle-down slowly. Throttling-down slowly will prevent chill-shocking the outboard power head and prolongs engine life.

PREPARING THE BOAT FOR ELECTROFISHING

1. Raise and inspect the booms, boom extensions, and arrays to see that they are in good working order. When attaching the arrays, connect the safety line first, then attach the quick connector. Do not unfold your arrays at this time.
2. Loosen clutches and lift the booms from the underway position. Swing booms forward to about 45° from forward. Tighten boom clutch assemblies to hold booms in position. Adjust anode depth with chain adjustments, elements extended about 2ft. into the water.
3. After the booms are adjusted, start the generator and allow it to warm up for a minute or two. Check to see if cooling water is being discharged with the exhaust.
4. See "Electrofisher" section to operate electrofisher.



FUEL SYSTEM

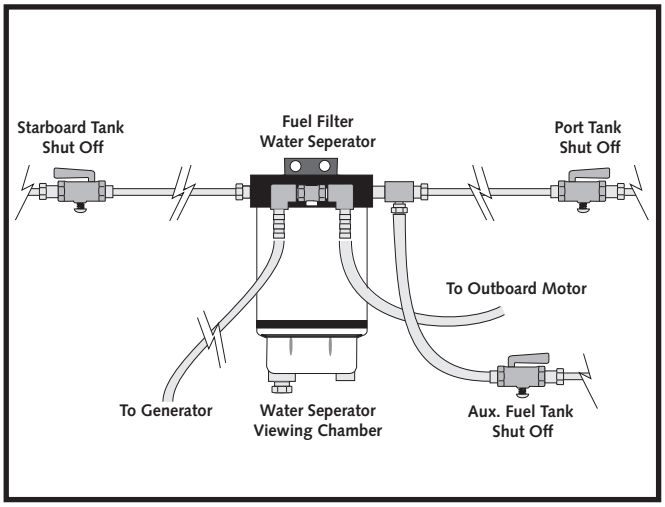
Smith-Root boats come with a water separator fuel filter and generator fuel pump.
Always use outboard manufacturer's recommended fuel.

MAINTENANCE

Check fuel filter viewing chamber for signs of water daily. Refer to your OEM Manual.

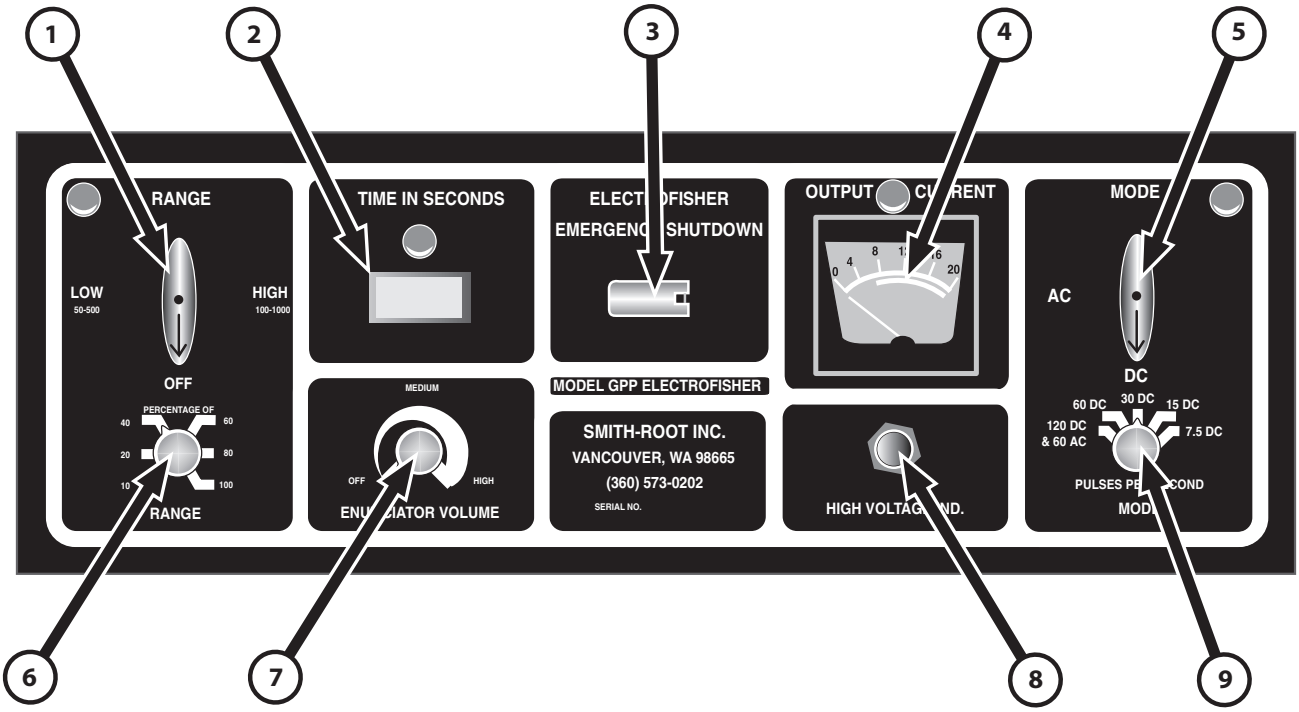
TO RE-PRIME YOUR OUTBOARD FUEL SYSTEM

First plug the auxiliary fuel hose to the auxiliary fuel tank (the tank that comes with the outboard motor). Then open the port tank shut off valve and pump the priming bulb 18 or 20 times. Then close the port tank valve and open the starboard tank valve. Now pump priming bulb 5 or 6 times. Now close Starboard tank valve and pump priming bulb until it becomes firm. Your fuel filter, generator fuel pump, outboard fuel pump and carburetors are now primed. Now remove auxiliary fuel tank hose from tank and adjust shut off valves to suit your needs.



GPP OPERATION

GAS POWERED PULSATOR



ELECTROFISHER CONTROLS

1 - RANGE: Selects the output voltage range between high and low or switches the output to OFF (**Caution!: The position of this switch should not be changed when current is flowing i.e. foot switches engaged!**)

2 - TIME IN SECONDS: Records the actual shocking time. It counts only when high voltage is applied.

3 - EMERGENCY SHUTDOWN: Provides a local override of remote foot switches.

4 - OUTPUT CURRENT: Shows the current flowing between the anode and cathode in amps. *Low range* indicates that the RANGE switch should be moved to the LOW position. For 7.5 and 9.0 GPPs, follow the output table.

5 - MODE: Selects the type of output pulses, AC, DC or OFF (**Caution!: The position of this switch should not be changed when current is flowing i.e. foot switches engaged!**).

6 - PERCENT OF RANGE: Adjusts the output pulses to a percent of the selected range, i.e. high/low. Pulse width is also automatically adjusted between 6 and 1 millisecond pulse duration.

7 -ENUNCIATOR VOLUME: The Audio Alarm warning tone indicates an output voltage. The control adjusts the volume of the Audio Alarm or turns the Audio Alarm off*.

8 - HIGH VOLTAGE: Red indicator lamp shows when voltage is present on output power terminals.

9 - PULSES PER SECOND: Selects the number of pulses in the output wave form.

*Note: Switch the Mode and Range switches to the OFF position when the GPP is not in use. The Audio Alarm warning tone will sound if the generator is running without the electrodes in the water and the switches are not OFF.

POWER SUPPLY CONTROLS

GENERATOR. Your GPP is powered by a specially manufactured gas-powered generator. The generator is wound so that the output voltages are taken directly from the generator, eliminating the need for a transformer or voltage-doubler. The generator has a self-excited, revolving field. This rotor connects directly to the engine crankshaft with a tapered fit. The stationary armature has a separate excitation winding, and multiple windings to supply AC power.

Two 12 VAC windings on the generator provide up to 500 watts of 12 volts AC power. They will run the 12 volt work lights and will recharge batteries.

ENGINE. This instruction section covers the electrofisher and the generator, but not the engine. Please read instructions in the engine manufacturer's section. The engine manufacturer has established an excellent worldwide service organization. Engine service is usually available from an authorized engine dealer near you: Check your Yellow Pages or contact Smith-Root, Inc. for a dealer near you.

ENGINE GOVERNOR. The engine must be run at 3600 rpm to supply the power it was designed to produce. The governor on the engine holds the speed as nearly constant as possible. The governor is set at the proper speed in the factory. Do not adjust the governor without proper tools.

VOLTAGE VARIATION. All engines slow down when a load is applied. When the electrical load on the generator is increased, the engine speed drops. This results in a lower voltage when the generator is loaded to its full capacity than when unloaded.

FREQUENCY VARIATION. The AC frequency is around 60 cycles per second. The inevitable variations in engine speed produce slight variations in the AC frequency. This has no noticeable effect on the operation of motors, lights, and your GPP electrofisher. However, clocks and other timing devices will not keep perfect time when used on generators.

MODIFICATIONS to the power supply that are not authorized may impair the function and safety of the unit.

ELECTROFISHER CONTROLS

MODE The large switch (located at top right of control panel) selects the type of output pulses, AC, DC or OFF (Caution: The position of this switch should not be changed when current is flowing, i.e. foot switches engaged). The small switch labeled PULSES PER SECOND selects the number of pulses in the output wave form 120, 60, 30, 15, 7.5 Hz. This switch selection may be changed at any time. However, it must be in the 120 position for AC output (gives 60 Hz. AC out).

Outputs on all selections are fast-rising slow-falling pulses (a filtered DC output option is available).

RANGE selects the output voltage range between high and low or switches the output to OFF. (Caution: The position of this switch should not be changed when current is flowing, i.e. foot switches engaged).

PERCENT OF RANGE adjusts the output pulses to a percent of the selected range, i.e. high/low. Pulse width is also automatically adjusted between 6 and 1 millisecond pulse duration.

HIGH VOLTAGE red indicator lamp shows when voltage is present on output power terminals.

ENUNCIATOR VOLUME The Audio Alarm warning tone indicates an output voltage. The control adjusts the volume of the Audio Alarm or turns the Audio Alarm off.

Note: *Switch the Mode and Range switches to the OFF position when the GPP is not in use*. The Audio Alarm warning tone will sound if the generator is running without the electrodes in the water and the switches are not OFF.

OUTPUT CURRENT this meter shows the current flowing between the anode and cathode in amps. LOW RANGE indicates that the RANGE switch should be moved to the LOW position. For 7.5 and 9.0 GPPs, follow the output table.

TIME IN SECONDS records the actual shocking time. It counts only when high voltage is applied. The timer helps evaluate capture effectiveness. The counter can be reset to zero by pushing the small red button on front panel.

EMERGENCY SHUTDOWN provides a local override of remote foot switches.

ELECTROFISHER OUTPUT PATCH PANEL: Located in a locking compartment in the forward section of the steering and control console with the Circuit Breaker panel. This compartment should never be opened with the GPP Electrofisher in operation.

The patch panel consists of four large "banana jacks" and Four cables terminated with large "banana plugs".

Using the patch panel, it is possible to easily change the output configuration of your boat to optimize it for various conditions that are encountered. Configurations supported are: boat as cathode one or two booms as anode, one boom as anode second boom as cathode, cathode array (if equipped) as cathode and one or two booms as anode.

Power is supplied from the banana jacks to the boat component designated by the plug wire connected.

When not actually being used, plugs may be left unconnected; however, the normal configuration is port and starboard booms patched as anodes and boat and/or cathode array patched as cathodes.

ELECTROFISHER SAFETY SWITCH OPERATION:

Adjust foot switch system to desired configuration. On the lower right-hand corner of the Console Control Panel is a foot switches control switch. In the "BOTH" position both work deck foot switches and the boat operator's foot switch must be engaged simultaneously to activate the GPP. In the "SEPARATE" position only one (either one) work deck switch and boat operator's switch needs to be engaged to activate the GPP. The function of the boat operators foot switch (pilot deck switch) is selected by a switch located in the Circuit Breaker panel compartment marked "COMMAND CENTER FOOT SWITCH". If this switch is in the "ACTIVE" position, the boat operator foot switch must be pushed for the GPP to work.

If this selector switch is in the "INACTIVE" position, the pilot deck foot switch has no effect. Also located in the Circuit Breaker panel compartment are the "AUXILIARY FOOT SWITCH & CONTROL" switch and plug. If you are using an auxiliary foot switch, plug it into the 4 pin socket and switch the "CONTROL" switch to "ACTIVE." This puts your auxiliary foot switch into the control circuit. When *not* using an auxiliary foot switch, make sure that the "CONTROL" switch is in the "INACTIVE" position.

1. Set Emergency Shutdown Switch to OFF.
2. Place the anode and cathode in the water. (not touching each other).
3. Check engine oil level; if low, fill with type recommended in engine operating manual for your operating environment. The low oil light on boat operator panel will illuminate under low oil conditions.
4. Open fuel tank shut-off valves (if so equipped) if using an auxiliary tank prime system with squeeze bulb.
5. Turn to the start position (full clockwise), release to the run or ignition on position when engine reaches full operating RPMs.
6. On the Electrofisher, set the MODE selector switch to the desired mode. If you are not sure which mode you desire, start with 120 pps DC (this will put the maximum amount of power in the water at the selected voltage).
7. Set the PERCENT OF RANGE to the minimum.
8. Set the RANGE selector switch to LOW.
9. Set EMERGENCY SHUTDOWN switch to ON.
10. Set the ENUNCIATOR VOLUME to mid-range.
11. Activate the remote control switch (foot switch). The high voltage indicator lamp and audio alarm should both come on and the ammeter will deflect.

12. Adjust the PERCENT OF RANGE switch to achieve optimum response by the fish. Deactivate the shutdown switch when switching to HIGH RANGE. **Damage to the range selector switch may result from switching under load.** Experimentation will be required to learn what mode and voltage settings are best for various water conditions and types of fish. See charts below:

13. If the ammeter shows LOW RANGE and the RANGE selector is in the HIGH position, switch to the LOW position. The low voltage windings on the generator are capable of delivering more current than the high voltage windings. If erratic operation occurs in the high range, switch to the low range. Do not operate the generator above the power ranges indicated on the meter, or possible engine and generator damage may occur.

Maximum GPP Amperage (2.5 - 5.0)

Model	High	Low
2.5	4 Amps	8 Amps
5.0	8 Amps	16 Amps

Maximum GPP Amperage (7.5 - 9.0)

Model	AC	DC	Amperage
7.5	120 V	170 V	62.5 A
	240 V	340 V	31.3 A
	360 V	500 V	20.8 A
	720 V	1000 V	10.4 A
9.0	60 V	85 V	150 A
	120 V	170 V	75 A
	240 V	340 V	37.5 A
	480 V	680 V	18.8 A

GPP Amperages by Model

13. If you have been working your GPP hard, run it for another five minutes under no load before shutting the generator down. This allows the electrical components to cool down slowly, extending their life considerably.

14. Turn the fuel valves to the OFF position when the boat is transported over long distances or on rough roads.

15. Turn the battery switches to OFF when not in use, except when charging the batteries.

ENGINE & GENERATOR MAINTENANCE

Before cleaning or inspecting, make certain all moving parts have stopped and cooled down. Do not put hands, feet, tools or other objects near rotating parts. Always wear eye protection.

1. CHANGE ENGINE OIL after first five hours of operation. Thereafter, refer to the OEM maintenance schedule which can be found in the Generator's OEM Manual.

   To drain the engine oil; place one end of a 3/8" dia. hose on the oil drain and thread the other end through the transom drain hole. Place the end of the hose onto a container. Turn the handle on the shut-off valve and let the oil drain into the container. (Be sure to dispose of the oil properly). Refill the engine with new oil. Check dip stick for proper oil level.

2. SPARK PLUG. Clean and reset gap to specs found in OEM Manual every 100 hours of operation.

3. FUEL. Every 250 hours replace the in-line fuel filter or clean the bowl.

4. CHECK GUARDS. Operate the generator engine only with the guards and shields in place and working correctly. If rotating parts are left exposed they are hazardous.

5. INSPECT GENERATOR BRUSHES after every 100 hours of operation and replace when worn to 3/8 inch (1cm) or less. Consult Generator's OEM Manual.

WINTERIZATION

OUTBOARD

1. Disconnect or shut off fuel.
2. Run engine to eliminate fuel from carburetors (until engine quits).

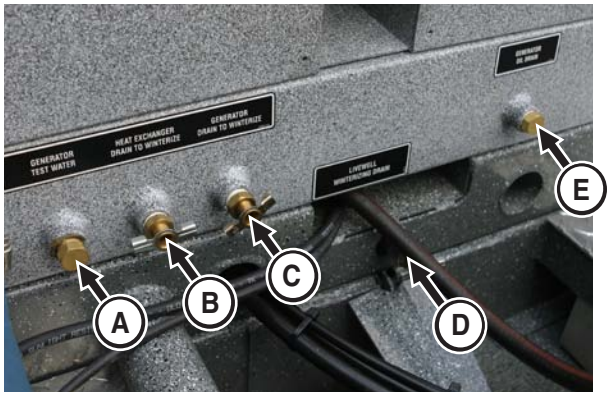
   Note: Do not run engine without water; use hose adapter recommended by outboard manufacturer.

   Note: Do not run engine tilted up.
3. Remove spark plugs.
4. Spray fogging oil in each cylinder.
5. Cycle the engine (manually or electrically).
6. Spray each cylinder again and replace the spark plugs.
   Note: Do not connect plug wires.
7. Spray fogging oil into carburetor air intakes.
8. Cycle the engine (manually or electrically).
9. Replace plug wires.
10. Replace engine shroud.
11. Store boat with outboard tilted down, if possible.
12. Check owner's manual for additional advice.

GENERATOR

1. Leave fuel valves turned off. Start engine to drain carburetor bowl.
2. Remove spark plug and spray fogging oil into cylinders.
3. Cycle engine (manually or electrically).
4. Spray cylinders again and replace spark plugs.

   Do not reconnect plug wires.
5. Cycle engine again.
6. Now replace the plug wires.
7. Change the oil and filter:
   a. Connect hose to 3/8" pipe fitting marked "Oil Drain" located behind Generator Housing.
   b. Route Oil Drain Hose through Stern Drain in Transom.
8. Open Winterizing Drain Valve (behind Gen. Housing) to drain raw water from Generator.
9. Drain the water from the generator cooling hose by removing the cap from the "T" fitting located inside the generator compartment, below the compartment light. Replace the cap and tighten by hand.



10. Drain water strainer located on side of console.
11. Open cover from generator water pump and lubricate impeller with silicone grease.

BATTERIES

Connect Automatic Battery Charger with maintenance float feature to the connector labeled "Battery Charger" on the Console.

FUEL SYSTEM

1. When you fill up the onboard fuel tanks for the last trip of the year, add a fuel stabilizer to it.
2. After returning from the last field trip, top off the fuel tanks with fuel and conditioner.
3. With fuel shut-off valves turned off, remove and discard the old fuel filter.
4. Install a new fuel filter per manufacturer's instructions.
5. Do not re-prime the fuel filter at this time.
6. Leave fuel shut-off valves turned off.
7. **Note:** Leaving your fuel tanks full will minimize condensation build-up inside the fuel tank.

FISH TANK DRAINING

1. Locate Livewell Winterizing Drain valve. Open valves to drain any water into bilge.

BOAT WINTERIZING CHECK OFF LIST

OUTBOARD — COMPLETED BY

1. Run carburetor ..... ❑ _____
2. Fog engine ..... ❑ _____
3. Re-Install plugs and wires ..... ❑ _____
4. Check owners manual. ..... ❑ _____

GENERATOR

1. Run carburetor/s dry ..... ❑ _____
2. Fog engine ..... ❑ _____
3. Re-Install plugs & wires ..... ❑ _____
4. Change oil and oil filter ..... ❑ _____
5. Drain raw cooling water from Gen ..... ❑ _____
6. Check owner's manual. ..... ❑ _____

BATTERIES

1. Connect Maintenance/Float Charger ..... ❑ _____

PUMPS

1. Remove and store impellors ..... ❑ _____

FUEL SYSTEM

1. Add fuel stabilizer. ..... ❑ _____
2. Shut off fuel valve/s. ..... ❑ _____
3. Install new fuel filter. ..... ❑ _____

LIVEWELL TANK

1. Drain Tank. ..... ❑ _____

SPECIFICATIONS

SPECIFICATIONS			
	5.0 GPP	7.5 GPP	9.0 GPP
Conductivity Range	10 to 5,500 microsiemens/cm^3	10 to 11,000 microsiemens/cm^3	100 to 25,000 microsiemens/cm^3
Rated Output Power	5,000 W	7,500 W	9,000 W
Rated Output Max. Current	16 A	62 A	150 A
12 VAC Auxiliary Power*	2 @ 500 W 42 A	2 @ 500 W 42 A	2 @ 500 W 42 A
Output Pulse Modes	Pulsed AC & DC	Pulsed AC & DC	Pulsed DC
DC Output Peak	0 to 500 V Low 0 to 1000 V High	0 to 1000 V in 4 steps	0 to 680 V in 4 steps
AC Output RMS	0 to 350 V Low 0 to 700 V High	0 to 700 V in 4 steps	N/A
Output Pulse Frequency	7.5, 15, 30, 60& 120 Hz	7.5, 15, 30, 60 & 120 Hz	7.5, 15, 30, 60 & 120 Hz
Output Current Metering	AC & DC 0 to 25 A	AC & DC 0 to 199 A	DC 0 to 199 A
High Voltage Output Indicator	Panel Lamp & Audio Tone	Panel Lamp & Audio Tone	Panel Lamp & Audio Tone
Output and Safety Control	Foot Switch & Panel Switch	Foot Switch & Panel Switch	Foot Switch & Panel Switch
Seconds Timer LCD Display	0 to 999,999	0 to 999,999	0 to 999,999
Cooling Method	Convection	Convection	Fan Cooled
Output Connectors	CPC with 15" Cable	CPC with 15" Cable	POS. CAM CONN. 15" Cable
Engine Size	11 HP	16 HP	16 HP
Generator Weight	210 lb	228 lb	238 lb
Pulsator Weight	20 lb	30 lb	35 lb
Generator Dimensions	28" L x 21.5" W x 20" H	28" L x 21.5" W x 20" H	28" L x 21.5" W x 20" H
Pulsator Dimensions	17.5" L x 17.5" W x 13" H	20" L x 15" W x 16" H	20" L x 15" W x 16" H

* Note: 12 VAC auxiliary power subtracts from Electrofisher power available.

Specification subject to change without notice.

PROCEDURE #1: CHECK GENERATOR AC VOLTAGES INSIDE CONSOLE.

TEST 12 VOLT AC OUTPUT*

A. Set GPP Voltage Range Switch to "off". Start Generator. Set engine speed to 3600 RPMs.
B. Check the VAC on TS-1 using a voltmeter (fig. 1.1) pairs: (1&4 and 6&7). They should read 14.5V, 60Hz. If 14.5-Volts AC are not present, go to C or D. If Voltages are okay, go to Procedure 2.
C. Flash Generator.

   Restart Procedure 1.

D. Test Battery Charger Circuit. Pull out on center button of the circuit breaker (Fig. 1.2, 1.3). If 14.5 volts are present, Battery charging circuit is shorted and needs to be repaired.
E. If still no 14.5 Volts AC, shut off generator and then remove wire pairs (1&4 and 6&7) from generator to TS-1 (fig. 1.1). Retest for 14.5 volts connected directly to each pair (black/black, white/white).

   If 14.5 volts are now present, a short circuit exists inside the console.

F. Check each wire pair to the boat ground. Measurements should be greater than 500 ohms. If resistance is low, wire insulation may be damaged and shorting to ground.

   Go to Procedure 3.

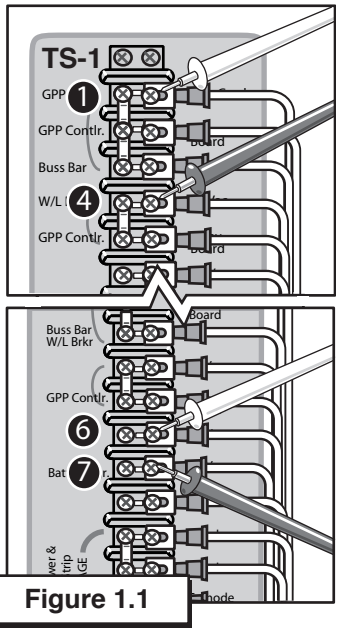


Figure 1.1

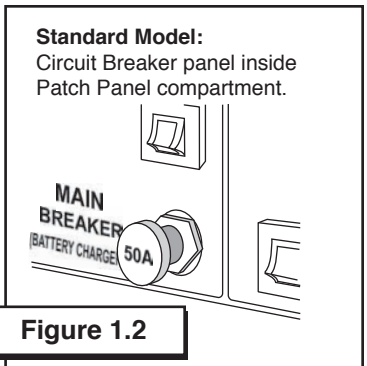


Figure 1.2

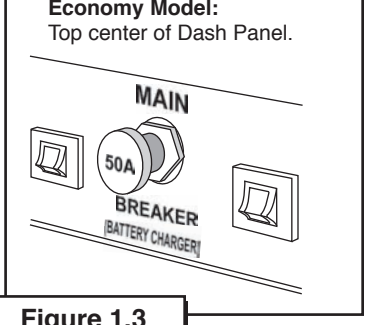


Figure 1.3

⚠ ***High voltage is present inside the console while the generator is running. Only qualified personnel should attempt high voltage measurements.** ⚠

PROCEDURE #2:
TEST HIGH VOLTAGE AC OUTPUT INSIDE CONSOLE*

A. Set Voltage Selector Switch to "OFF".

B. Check each of the high voltage terminal pairs on TS-0 for 120 Volts AC * (fig. 2.1) Pairs: 1&2, 3&4, 5&6, 7&8, 9&10, and 11&12.

C. If voltage measures 120 Volts AC for each pair, go to E.

D. If voltage measures low, check terminals 1-12 to boat ground. All terminals should show open or high resistance (Greater than 500 Ohms). If resistance is low, wire insulation may be damaged and shorting to ground.

Go to Procedure 3.

E. Switch GPP Voltage Range Switch to "LOW". Retest all of Procedure 2. If low voltages are found, one or more windings may be out of phase.

F. Switch GPP Voltage Range Switch to "HIGH".

Retest all of Procedure 2.

G. Measure voltages on TS-0, pins 1 to 12. They should read 720 VAC RMS.

If Voltage Is Okay, go to Procedure 6

If voltage NOT Okay, contact SRI.

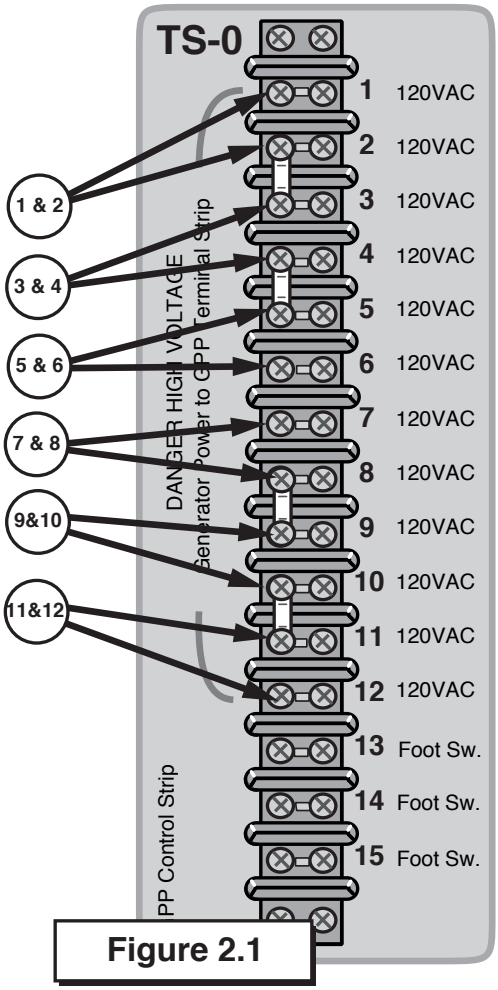


Figure 2.1

⚠ WARNING

High voltage is present inside the console while the generator is running.
Only qualified personnel should attempt high voltage measurements.

PROCEDURE #3: TEST GPP BOX CONTROL CIRCUIT

A. Turn Generator off.

B. Connect a jumper wire across the foot switch connection (PINS 13 & 15) on TS0 to bypass the foot switches. (Fig. 3.1)

C. Connect console "Patch Panel" as shown. (Fig. 3.2)

D. Connect test load to boom and cathode (See Procedure 6).

Warning - Keep all personnel clear of booms and the test load while the generator is running.

E. Switch mode switch to 120 PPS.

F. Turn Percent of Range Control to 50%.

G. Switch output voltage selector switch to low range.

H. Switch the Emergency Shutdown Switch to OFF position (Caution: this is now the only on/off control for the GPP control box).(Fig. 3.3)

I. Start the Generator.

J. Switch the Emergency Shutdown Switch to the ON position.

K. The red light on the front panel should now be illuminated and the amp meter should indicate amperage.

L. If the red light is not illuminated and the amp meter indicates no amperage:

   a. Generator off.

   b. Check the light bulb.

   c. Check the fuse on the GPP main circuit board.

   d. Replace fuse if blown (Fig. 3.4). A blown fuse may indicate a short circuit in power to Work Lights or Audio Alarm.

   e. Disconnect Audio Alarm from GPP control box.

   f. Test Booms individually for shorts due to damage to insulation of cables using a Hi-pot tester.

Return to start of Procedure 3.

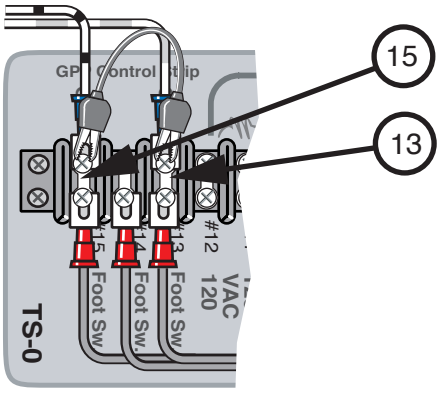


Fig.3.1

Fig.3.2

Fig.3.3

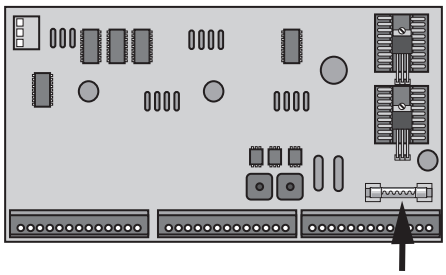


Fig.3.4

M. If Red light and amp meter indicate output, go to Procedure 4.

N. If no output indication then return GPP control box to Smith-Root, Inc. for service.

PROCEDURE #4:
TEST THE GPP'S OUTPUT

WARNING – KEEP ALL PERSONNEL CLEAR OF BOOMS AND TEST LOAD WHILE GENERATOR RUNNING.

A. Maintain GPP settings from procedure #3.

B. Start Generator.

C. Switch the Emergency Shutdown Switch (1) to the ON position.

Fig. 4.1

D. When the red light is on, the current meter should show amperage and the seconds counter should be counting.

E. If there is no display in the seconds counter, replace the "N" cell batteries in the counter

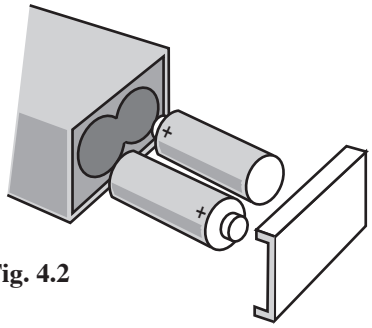


Fig. 4.2

(the batteries should be replaced every 5 years). (Figure 4.2)

F. Adjusting the percent of range (2) up to 100 percent will increase the amperage shown on the front panel meter.

G. Set the percent of range at 50 percent.

   a. Switch the Mode switch (3) from 120 PPS to 60 PPS. The amperage should drop by 1/2.

   b. Switch the Mode switch from 60 PPS to 30 PPS. The amperage should drop again by 1/2.

   c. Switch the Mode switch from 30 PPS to 15 PPS. The amperage should drop again by 1/2.

   d. Switch the Mode switch from 15 PPS to 7.5 PPS. The amperage should drop again by 1/2.

H. Switch the Emergency Shutdown Switch to the OFF position.

I. Switch the voltage switch to the high range.

J. Return to C and retest settings in the High Range.

IF NO OUTPUT, RETURN CONTROL BOX TO SRI.

PROCEDURE #5: TEST BOAT FOOTSWITCH CIRCUITS

A. Turn Generator off.

B. Remove foot switch jumper from Procedure 3 from TS-0 (pins 13 & 15). (Fig. 5.1).

C. Set foot switch control to "Separate"(Fig. 5.2).

D. Switch to "inactive", the Command Center foot switch and the Auxiliary foot switch from inside the front compartment of the console (Fig. 5.3).

E. Start Generator.

F. Close each work deck foot switch circuit (push on switch).

G. The red light should turn on.

H. Set the foot switch control to "BOTH".

I. Close both of the bow foot switches at the same time.

J. The red light should turn on.

K. Switch the Command Center foot switch to "ACTIVE."

L. Close both of the Work Deck foot switches and the Command Center foot switch.

M. The red light should turn on.

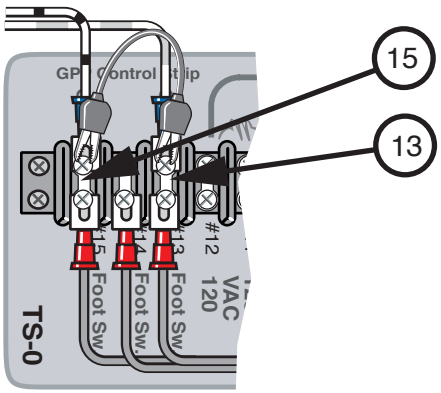


Fig. 5.1

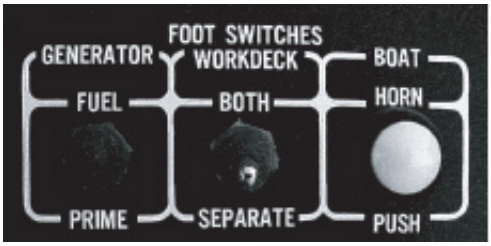


Fig. 5.2

Fig. 5.3

Foot switch problems can be caused by:

1. Misadjusted switch (try pushing on the switch directly with your finger).
2. Broken wire (this will need to be traced with an Ohmmeter).
3. Broken switch (try a jumper across the switch).
4. Incorrect Switch settings.

PROCEDURE #6:
CONSTRUCT A TEST LOAD

⚠ Warning! – Keep all personnel clear of booms and test load ⚠ while generator is running!

1. Construct a test load using a plastic bucket with the metal handle removed (Fig. 1.1).
2. Connect the test load to the boat as shown (Figs. 1.2-1.3).
3. Add tap water to the bucket.
4. Set the "Mode Switch" on the GPP control box to AC & 120 PPS/ 60 AC.
5. Start the generator.
6. Control the GPP output with the Emergency Shut Down switch or Footswitch.
7. By turning the percent of range control up to 100% and checking the amp meter on the GPP control box, the correct load can be determined. See below

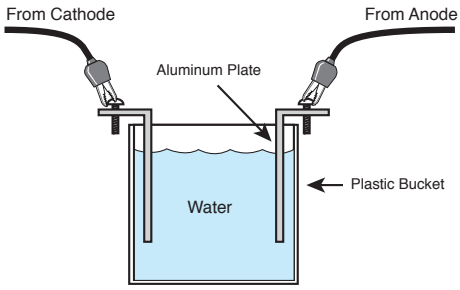


Fig. 6.1

Maximum GPP Amperage (2.5 - 5.0)

Model	High	Low
2.5	4 Amps	8 Amps
5.0	8 Amps	16 Amps

Maximum GPP Amperage (7.5 - 9.0)

Model	AC	DC	Amperage
7.5	120 V	170 V	62.5 A
	240 V	340 V	31.3 A
	360 V	500 V	20.8 A
	720 V	1000 V	10.4 A
9.0	60 V	85 V	150 A
	120 V	170 V	75 A
	240 V	340 V	37.5 A
	480 V	680 V	18.8 A

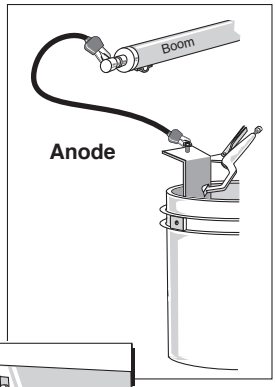


Fig. 6.2

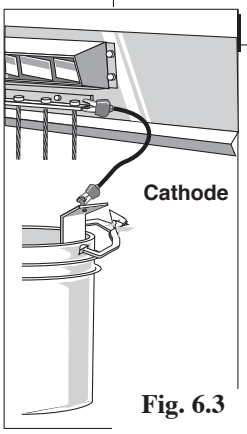


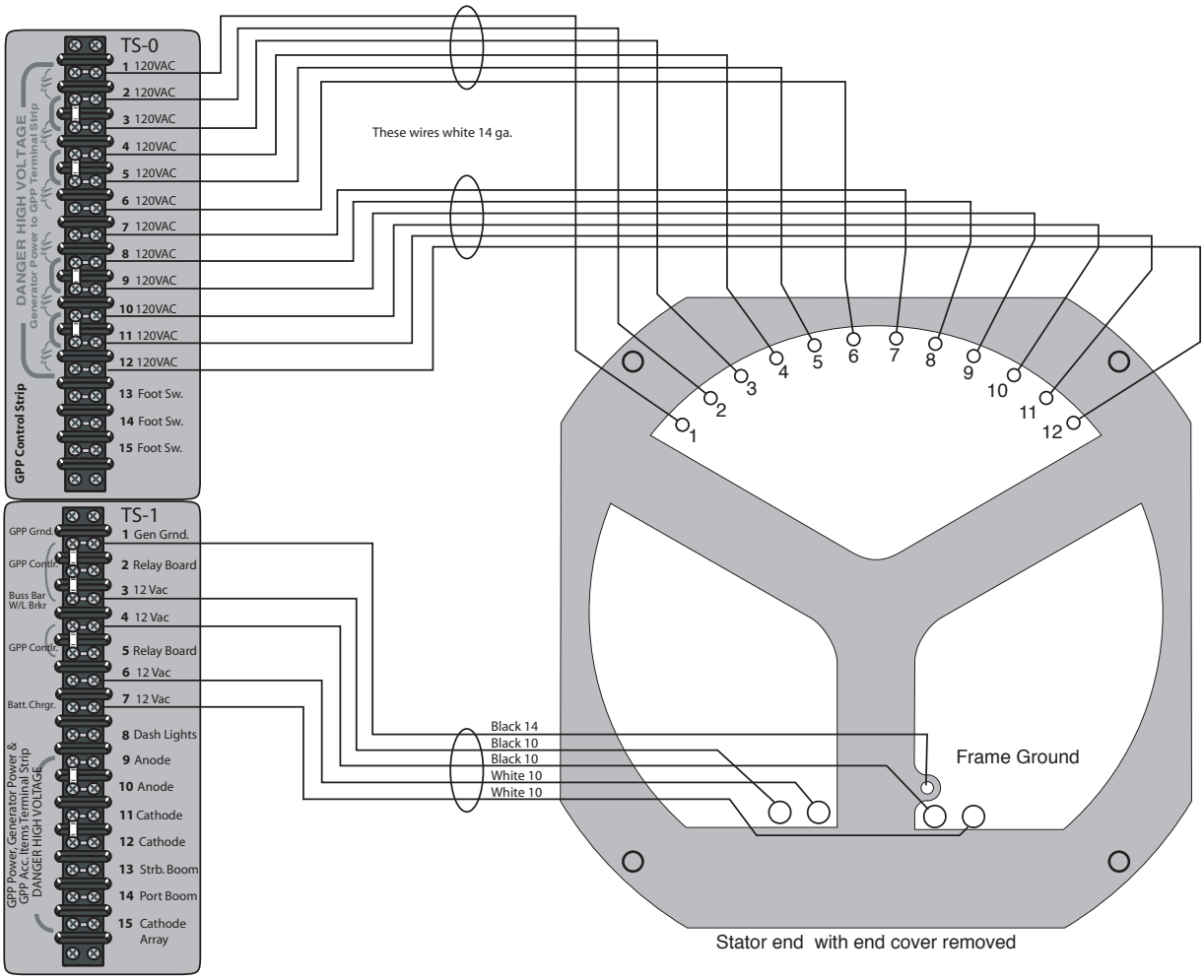
Fig. 6.3

8. The amp meter will increase to the maximum as you turn up the Percent of Range.
9. The load may be increased by slowly adding table salt to the water in the bucket.
10. If the load is too great for the range selected, the GPP will operate erratically.
11. If the amp meter starts to show a decrease in amps or is erratic as the percent of range nears 100%, the generator is overloading. The water may need to be changed, or decrease the portions of electrodes immersed in the water .

⚠ Danger! High voltage is present during test load procedure. ⚠
Every effort should be made to keep all personnel away from test load bucket and booms. It may be necessary to form a barricade around testing area and post appropriate signs warning of high voltage.

BOAT GENERATOR STATOR WIRING DIAGRAM:

5.0 AND 7.5 GPP



Generator Terminals
1 - 2 = 115 Volts @ 1250 VA
Respectively through
11 - 12 = 115 Volts @ 1250 VA

(Pairings of Odd # on Left & Even # on Right.)

Output @ Binding Posts
Black wires 12 Volts @ 500 VA
White wires 12 Volts @ 500 VA

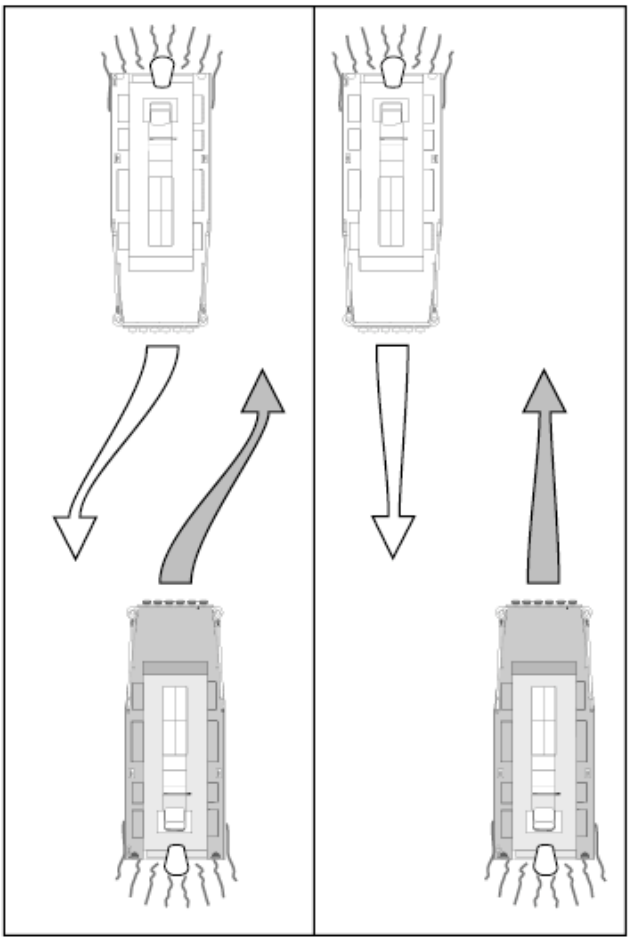
ELECTROFISHING BOATS
STANDARD BOATING RULES

Standards Boating Rules Contents:

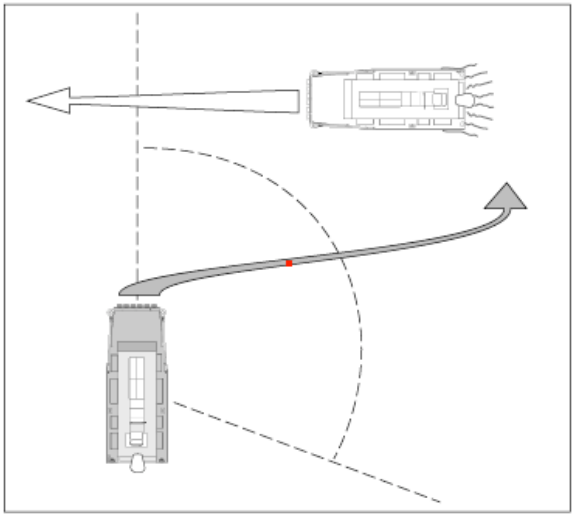
Right-Of-Way 33
Buoys and Other Markers 34
Lightning and Thunderstorm Protection 35
Guide to Personal Thunderstorm Protection 38

RIGHT-OF-WAY

Meeting: If you are meeting another power vessel head on, and are close enough to run the risk of collision, neither of you has the right-of-way! Both of you should alter course to avoid an accident. You should keep the other vessel on your port (left) side. This rule doesn't apply if both of you will clear one another if you continue on your set course and speed.



Crossing: When two power driven vessels are crossing each other's path close enough to run the risk of collision, the vessel which has the other on the starboard (right) side must keep out of the way of the other. If the other vessel is on your right, you must keep out of its way; you are the Give-Way vessel. If the other vessel is on your port (left) side, remember that you should maintain course and direction, provided the other vessel gives you the right-of-way as it should.

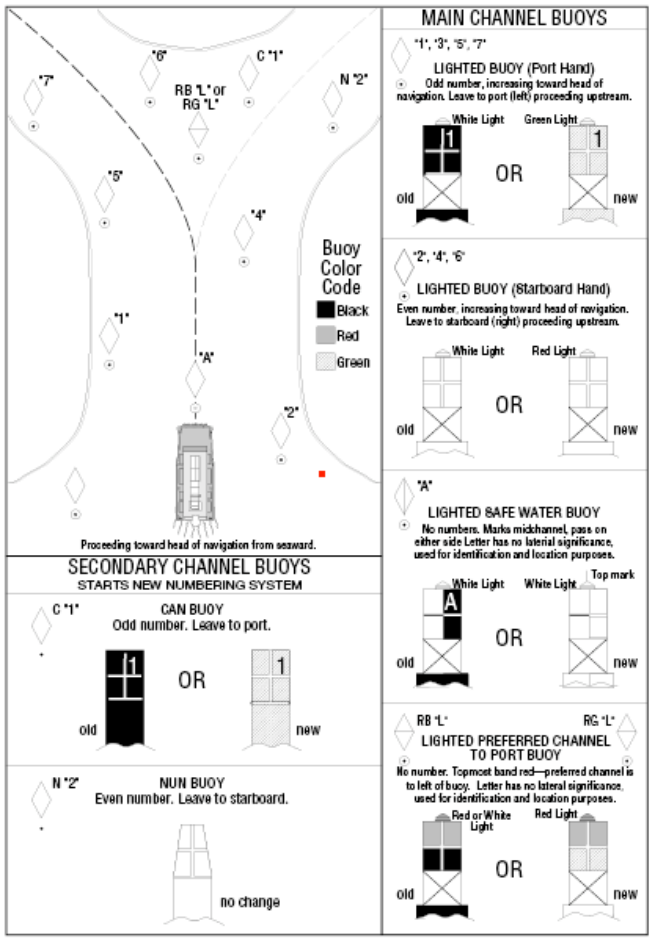


Overtaking: If you are passing another vessel, you are the "Give-Way" vessel. This means that the other vessel is expected to maintain its course and speed. You must stay out of its way until you are clear of it. Likewise, if another vessel is passing you, you should maintain your speed and direction so that the other vessel can steer itself around you.

OTHER SPECIAL SITUATIONS

There are three other rules you need to know when driving your boat around other vessels.

Narrow channels and bends: When navigating in narrow channels, you should keep to the right when it is safe and practical to do so. If the operator of a power-driven vessel is preparing to go around a bend that may obstruct the view of other water vessels, the operator should sound a prolonged blast on the whistle (4 to 6 seconds). If another vessel is around the bend, it too should sound the whistle. Even if no reply is heard, however, the vessel should still proceed around the bend with caution. If you navigate such waters with your boat, you must carry a portable air horn available from local marine supply stores.



Fishing vessel right-of-way: All vessels which are fishing with nets, lines or trawls are considered to be "fishing vessels" under the International Rules. Vessels with trolling lines are not considered fishing vessels. Fishing vessels have the right-of-way regardless of position. Fishing vessels cannot, however, impede the passage of other vessels in narrow channels.

Sailing vessel right-of-way: Sailing vessels should normally be given the right-of-way. The exceptions to this are:

1. When the sailing vessel is overtaking the power-driven vessel, the power-driven vessel has the right-of-way.

2. Sailing vessels should keep clear of any fishing vessel.

3. In a narrow channel, a sailing vessel should not hamper the safe passage of a power-driven vessel which can navigate only in such a channel.

Reading buoys and other markers: The waters of the United States are marked for safe navigation by the lateral system of buoyage. Simply put, buoys and markers have an arrangement of shapes, colors, numbers and lights to show which side of the buoy a boater should pass on when navigating in a particular direction. The markings on these buoys are oriented from the perspective of being entered from seaward (the boater is going towards the port). This means red buoys are passed on the starboard (right) side when proceeding from open water into port, and black buoys are to the port (left) side. When navigating out of port, your position with respect to the buoys should be reversed; red buoys should be to port and black buoys to starboard.

Many bodies of water used by boaters are entirely within the boundaries of a particular state. The Uniform State Waterway Marking System has been devised for these waters. This system uses buoys and signs with distinctive shapes and colors to show regulatory or advisory information. These markers are white with black letters and orange boarders. They signify speed zones, restricted areas, danger areas, and general information.

Remember, markings may vary by geographic location. Always consult local boating authorities before driving your boat in unfamiliar waters.

LIGHTNING AND THUNDERSTORM PROTECTION FOR SAILBOATS, POWER BOATS, SMALL BOATS AND SHIPS.

1. GENERAL PRINCIPLES

Successful protection of persons and watercraft from lightning is dependent upon a combination of proper design and maintenance of equipment, and on crew behavior. Proper design is covered in this and following sections. Maintenance of equipment and personnel behavior is also covered. In view of the wide variation in structural design of boats, specific recommendations cannot be made for all cases. However, basic guidelines should be considered and used in designing and installing a lightning protection system for any given craft.

A grounded conductor or lightning protective mast will generally divert itself to direct hits which might otherwise fall within a cone-shaped space, the apex of which is the top of the conductor or lightning protective mast and the base is a circle at the surface of the water having a radius related to the height. For a mast height not exceeding 50 ft., (15 m) above the water, this radius is approximately equal to the mast height.

To provide an adequately grounded conductor or lightning protective mast, the entire circuit from the top of the mast to the ground should have a conductivity not less than that of a No.8 AWG copper conductor and the path to ground followed by the conductor should be essentially straight. To remove all known risk of melting the conductor while carrying lightning current, conductivity equal to No.6 AWG or no. 4 AWG copper would be necessary. However, the risk in using No.8 AWG is considered adequately small in the applications under consideration, and in many cases will be mitigated by the presence of electrically paralleling stays. This statement should not be interpreted as permitting the use of conductors of conductivity less than that of No. 8 AWG copper.

If there are metal objects of considerable size within a few feet of the grounding conductor, there will be a strong tendency for sparks or sideflashes to jump from the grounding conductor to the metal object at the closest point. To prevent damage from such sideflashes, an interconnecting conductor at least equal to no. 8 AWG copper should be provided at all places where they are likely to occur. Large metallic objects that are not part of the electrical system of the boat and that are not already grounded due to their own functional or other requirements may be grounded to the ground plate, provided that it is not practical to interconnect with the lightning conductor or bonding systems.

Lightning protection provisions are quite likely to receive scant attention after installation and therefore their composition and assembly should be strong and materials used should be highly resistant to corrosion.

2 INSTALLATION RECOMMENDATIONS

Lightning Protective Mast. A lightning protective mast should be of adequate height and should be mechanically strong in order to withstand exposure to use and weather. If the mast is of nonconducting material, the associated lightning or grounded conductor should be essentially straight, securely fastened to the mast, should extend at least 6 in. (150 mm) above the mast, should preferably terminate in a receiving point, should be led as directly as practical to the grounding connection.

Radio Antenna. A radio antenna may serve as a lightning protective mast provided it has conductivity equivalent to No. 8 AWG copper and is equipped with lightning arresters, lightning protective gaps, or means for grounding during electrical storms. The grounding of metal rod-type radio antennas constitutes sufficient protection for wooden boats, without masts or spars, provided the following conditions are met:

The antenna and all conductors in the grounding circuit of the antenna have a conductivity equivalent to No.8 AWG copper.

The top of the antenna is not more than 50 ft. (15m) above the water, and a line drawn from the top of the antenna downward toward the water at an angle of 45 degrees to the vertical does not intercept any part of the boat.

Because a loading coil presents a high impedance to the flow of lightning current, the portion of an antenna above the bottom of a loading coil is not effective as a lightning protective mast unless the coil is provided with a suitable protective device for bypassing the lightning current.

Nonconducting antenna masts with spirally wrapped conductors are not considered suitable for lightning protection purposes.

3 MATERIALS

The materials used in the making of a protective system should be resistant to corrosion. The use of combinations of metals that form galvanic or electrolytic couples should be avoided.

In those cases where it is impractical to avoid a junction of dissimilar metals, the corrosion effects can reduce the use of suitable platings or special connectors, available for such purposes. Except for the use of conducting materials that are otherwise part of the structure of the boat, only copper should be used as the conductor. Where copper is used, it should be of the grade ordinarily required for commercial electrical work, generally designated as being 98 percent conductivity when annealed.

Figure 2

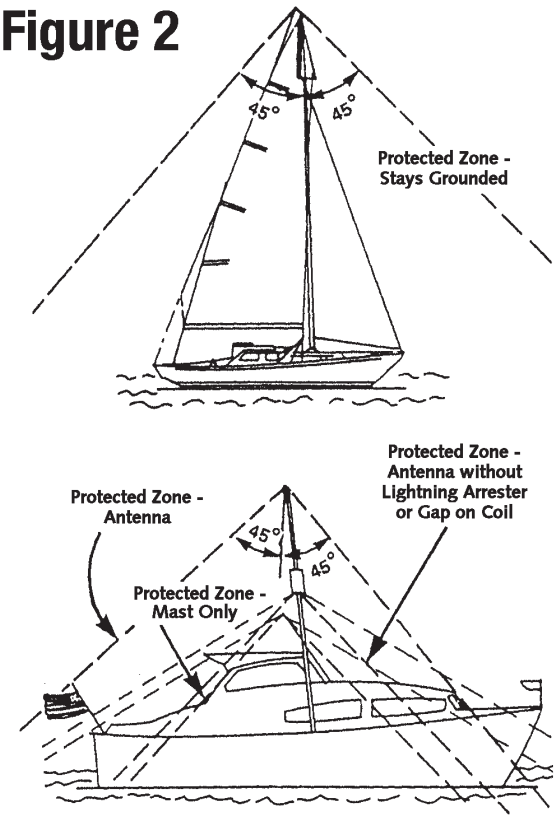


Figure 2. Diagrams the zone of protection provided by a grounded mast or antenna not more than 50 ft (15 m) above the water. This protective zone is largely immune to direct strokes of lightning. No part of the vessel to be protected should extend outside the zone of protection. Thus in the cabin cruiser illustrated, adequate lightning protection is afforded only by the grounded antenna equipped with a lightning arrester or gap on the coil.

Copper Conductor. Copper cable conductors should be of a diameter not less than No.8 AWG. The size of any strand of cable should be not less than No. 17 AWG. The thickness of any copper ribbon or strip should not be less than No. 20 AWG. Where other materials are used, the gauge should be such as to give conductivity equal to or greater than No. 8 AWG stranded copper cable.

Joints. Joints should be mechanically strong and should be so made that they have an electrical resistance not in excess of that of 2 ft (0.6 m) of conductor.

4. INTERCONNECTION OF METALLIC MASSES

Metallic masses aboard boats that are a permanent part of the boat or are permanently installed within or about it and whose function would not be seriously affected by grounding should, with exception of those of comparatively small size, be made a part of the lightning conductor system by interconnection with it.

The object of interconnecting the metal parts of a boat with the conductor is to prevent damage from sideflashes, especially in the case of many metal objects that are nearby. The main principle to be observed in the prevention of such damage is to identify on a boat the places where sideflashes are most likely to occur and to provide metallic paths for them.

To minimize flow of lightning discharge current through engine bearings, it may be preferable to bond engine blocks directly to the ground plate rather than to an intermediate point on the lightning conductor.

EXTERIOR BODIES OF METAL

Metal situated wholly on the exterior of boats should be electrically connected to the grounding conductor.

Exterior metal bodies on boats include any large masses such

as horizontal handrails on cabin tops, smoke stacks from galley stoves, davits, or metal signal masts.

INTERIOR BODIES OF METAL

Metal situated wholly in the interior of boats and which at any point comes within 6 ft (1.8 m) of a lightning conductor should be electrically interconnected with this lightning conductor.

Interior bodies of metal include engines, water and gasoline tanks, and control rods for steering gear or reversing gear. It is not intended that small metal objects such as compasses, clocks, galley stoves, medicine chests, and other parts of the boat's hardware be grounded.

Metal that projects through cabin tops, decks or sides of boats above the sheer should be bonded to the nearest lightning conductor at the point where the metal emerges from the boat and should be grounded at its lower or extreme end within the boat.

Radio transmitter antennas should be (a) equipped with means for grounding during electrical storms or (b) transmitters and antennas should be protected by lightning arresters or lightning protective gaps.

Ground Connection. A ground connection for a boat may consist of any metal surface that is normally submerged in the water and that has an area of 1 square foot (0.093 m2). Propellers and metallic rudder surfaces may be used for this purpose. The ground plate as required by the Federal Communications Commission for radio transmitters should be considered adequate. A metal hull itself constitutes an adequate ground.

Vessels with Metal Hulls. If there is an electrical contact between metal hulls and metal masts or other metallic superstructure of adequate height to meet the recommendations of Section 2, no further protection against lightning is necessary. Boats with ungrounded or nonconducting objects projecting above the metal masts or superstructure should have these objects grounded or protected with a grounded conductor, respectively, in order to protect them.

PROTECTION OF SAILBOATS (NONMETALLIC)

Sailboats. Sailboats with metallic standing rigging will be adequately protected provided that all rigging is grounded, so that the mast and rigging meet the recommendations of Sections 2 and 3.

Open Day-Sailors. Open sailboats will be adequately protected if any shrouds, backstays, or preventors, and any continuous metallic track on the mast and boom are grounded. These should be electrically connected at the lower or forward end and grounded to a copper plate on the hull or to a metal rudder, centerboard, or keel.

Cruising Sailboats. All stays and all sail tracks should be grounded on cruising sailboats since it is assumed that persons will be in proximity of fore-stays as well as after-stays. Grounding of other objects on cruising boats should be in accordance with the foregoing subsections.

PROTECTION OF POWER BOATS (NONMETALLIC)

Power boats may be adequately protected by a grounded radio antenna and other suitable grounded lightning protective mast provided the height of the mast meets the recommendations for the zone of protection in Figure 2. Interconnection and grounding of metallic masses should be in accordance with previous materials.

Where the size of the boat is such as to render the use of a single mast impractical, additional lightning protective masts should be erected to form overlapping zones of protection.

Protection of Small Boats. Small boats may be protected by means of a temporary lightning protective mast which may be erected when lightning conditions are observed in the distance. Grounding provisions may be made by means of flexible copper wire and a submerged ground plate of at least 1 sq ft (0.093 m2) in area.

PROTECTION OF SHIPS

Ships almost invariably are constructed with steel masts, spars, superstructures, hulls, smokestacks, and shrouds and the array of masts, stacks, and radio antennas usually provide the zones of protection recommended in Figure 2. Therefore, ships and personnel aboard them are usually inherently protected against the effects of lightning. In those

cases where adequate zones of protection are lacking, they should be corrected, if accomplished by changes in number or height of masts, or by shielding wires suspended between masts.

Fiberglass or wooden hulled sailing ships should be protected in accordance with Section 1, except that grounding and bonding conductors should have conductivity not less than that of No.4 AWG copper wire, and the copper grounding plate below the light water line should have an area not less than 36 square feet (3.3m2).

Precautions for Personnel

Inasmuch as the basic purpose of protection against lightning is to ensure the safety of personnel, it is appropriate that the following precautions and suggestions be listed in addition to all applicable recommendations already covered.

One should remain inside a closed boat, as far as practical, during a lightning storm, and should not dangle arms or legs in the water.

To the extent consistent with safe handling and navigation of the boat during a lightning storm, one should avoid making contact with any items connected to a lightning protection system and especially in such a way as to bridge between these items. For example, it is undesirable that an operator be in contact with reversing gear levers and spotlight control handle at once.

No one should be in the water during a lightning storm.

Maintenance suggestions

One should not have a whip-type radio antenna tied down during a lightning storm if it has been designed as part of the lightning protective system.

If a boat has been struck by lightning, compasses and electrical gear should be checked to determine whether damage or change in calibration has taken place.

GUIDE FOR PERSONAL SAFETY DURING THUNDERSTORMS

1. The purpose of this information is to furnish a guide for personal safety during thunderstorms.

Personal Conduct

Do not go out-of-doors or remain out during thunderstorms unless it is necessary. Seek shelter as follows:

(a) Dwellings or other buildings that are protected against lightning

(b) Underground shelters such as subways, tunnels, caves.

(c) Large metal-frame buildings

(d) Large unprotected buildings

(e) Enclosed automobiles, buses, and other vehicles with metal tops and bodies

(f) Enclosed metal trains and street cars.

(g) Enclosed metal boats or ships

(h) Boats that are protected against lightning.

(i) City streets that may be shielded by nearby buildings

If possible, avoid the following places, which offer little or no protection from lightning:

(a) small, unprotected buildings, barns, sheds, etc.

(b) Tents and temporary shelters

(c) Automobiles (nonmetal top or open)

(d) Trailers (nonmetal or open)

Certain locations are extremely hazardous during thunderstorms and should be avoided if at all possible. Approaching thunderstorms should be anticipated and the following locations avoided when storms are in the immediate vicinity:

(a) Hilltops and ridges

(b) Areas on top of buildings

(c)Open fields, athletic fields, golf courses

(d) parking lots and tennis courts

(e) swimming pools, lakes and seashores

(f) Near wire fences, clotheslines, overhead wires and railroad tracks

(g) Under isolated trees

(h) Avoid use of or contact with electrical appliances, telephones, and plumbing fixtures)

In the above locations, it is especially hazardous to be riding in or on any of the following during lightning storms:

(a) Open tractors or other farm machinery operated in open fields

(b) Golf carts, scooters, bicycles, or motorcycles

(c) Open boats (without masts) and hovercraft

(d) Automobiles (nonmetal top or open)

It may not be possible to always choose a location that offers good protection from lightning. Follow these rules when there is a choice in selecting locations:

(a) Seek depressed areas - avoid hilltops and high places.

(b) Seek dense woods - avoid isolated trees.

(c) Seek buildings, tents, and shelters with low areas-avoid unprotected buildings and shelters in high areas.

(d) If you are hopelessly isolated in an exposed area and you feel your hair stand on end, indicating that lightning is imminent, crouch down, keeping your feet together and arms in.

ELECTROFISHING SAFETY

SAFE FISHING

Electrofishing equipment uses voltages and currents that can be lethal to humans. The operators must always keep in mind that the chance of receiving an electrical shock is multiplied in or near water. Using an electrofisher is like using a firearm: if used properly and with good judgment it is perfectly safe; lose respect for it and you can lose your life!

Electrical equipment used in a moist field environment is always subject to deterioration that could lead to dangerous electrical shock. Field equipment is also subjected to vibration and impact during transporting and while in operation. Often equipment shared by different crews does not receive proper maintenance or a complete checkout.

Follow the safety guidelines, and use good common sense to handle unforeseen circumstances.

All personnel involved in electrofishing should be taught the fundamentals of electricity, and have an understanding of the safety requirements.

The most important factor in electrofishing efficiency and safety is the training and experience of the crew. At least two members of the crew should be qualified to administer cardiopulmonary resuscitation. As opportunities arise, all crew members should attend a course in basic life-support training.

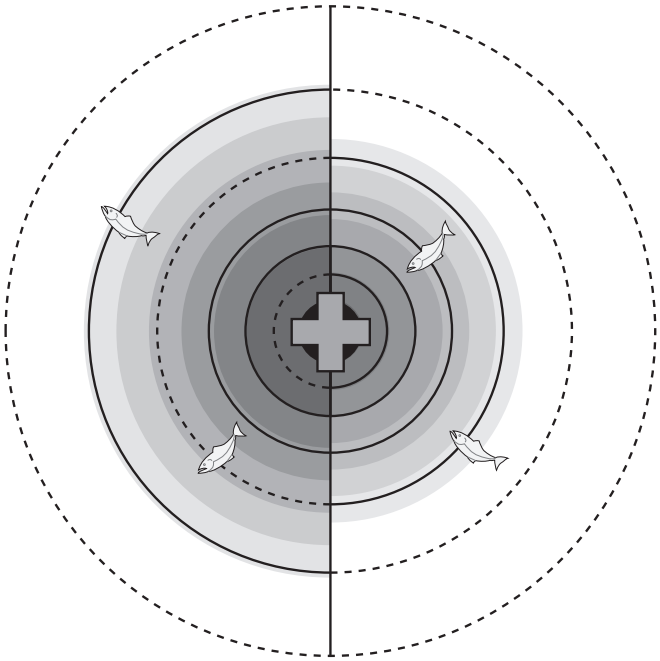
ELECTRICAL SHOCK

It is the current that passes through the human body that does the damage. The voltage is relevant, because it is the force that "pushes" the current through the body. Experiments show that 20 to 500 Hz AC current is more dangerous than DC, or higher frequencies of AC.

The voltages used by electrofishing gear cause death by one of three means:

Ventricular Fibrillation

Ventricular fibrillation is uncoordinated contraction of the muscles of the heart. The heart quivers rather than beats. Electrical current through the chest can cause this condition. Once a person goes into ventricular fibrillation, the only way to stop the quivering is to use a defibrillator that applies a pulse shock to the chest to restore heart rhythm. Cardiopulmonary resuscitation may help to keep a victim alive until he can be defibrillated.



Respiratory Arrest

The respiratory center is at the base of the skull. Thus, shocks to the head can cause the breathing to stop. Artificial respiration by the mouth-to-mouth method should be used in this case.

Asphyxia

Asphyxia is caused by contraction of the chest muscles. When a current is above a certain level, a person cannot let go of an electrically hot wire. Currents above this level may not cause ventricular fibrillation, but may be enough to cause contraction of the chest muscles. If the current is not stopped, or the victim is not removed from the point of electrical contact, asphyxia will result. Artificial respiration or cardiopulmonary resuscitation may be necessary.

ELECTROFISHING BOATS

PREVENTING ELECTRICAL SHOCK

Electricity needs to have a complete electrical circuit in order for current to flow. The only way that you can get shocked is if you become the electrical conductor to complete the circuit. The current flows from the cathode to the anode through the water. The water is the electrical conductor. If you touched both the anode and the cathode you would become an electrical conductor and complete the circuit path and get a severe electrical shock. If you were to touch only one of the electrodes, you would not complete the electrical circuit and not get shocked.

WARNING: ***Touching any electrode is not recommended. Unless all conductive objects you come into contact with are connected to the same electrode, you will be shocked to find a current path that is not obvious, e.g., the water, or the boat.***

Preventing electrical shock means preventing electrical current from entering and flowing through parts of the body. The skin is a partial but variable barrier, because it offers resistance to the passage of electrical current. Tough skin has more resistance than tender skin, and dry skin more than wet skin. But tough dry skin alone does not offer enough protection for electrofishing. Rubber lineman's gloves, rated 5,000V minimum should always be worn.

Even while wearing rubber gloves and waders, never touch an electrode while the circuit is energized.

Do not work on the electrical system while the generator is running. Do not enter the water while the current is on during boom shocking operations.

A severe electrical shock from electrofishing gear may result in the need for artificial respiration; therefore, it is imperative that no one ever works alone.

To prevent electrical shock, all electrical equipment should be carefully inspected before each field operation. With all electrical equipment in good operating condition, and all insulation, junction boxes, bonding, and connections intact, there is much less danger of receiving an electrical shock.

PLANNING FOR SAFETY

1. Never electrofish alone! A minimum of two properly trained people is required for every electrofishing crew.
2. A crew leader shall be appointed for all electrofishing. The crew leader is responsible for the safety of the crew, and the enforcement of all safety regulations.
3. The crew leader, and at least one additional crew member, shall receive training in cardiopulmonary resuscitation (CPR), and First Aid.
4. All electrofishing personnel shall receive training in fundamentals of electricity and safety.
5. Check your electrofisher before each operation, to ensure that it is in good working order.
6. Turn off your electrofisher before making any connections or part replacements.
7. When not in use, and when transporting the unit, disconnect the power supply.
8. Check that the electrofisher gives an audible signal when there is voltage present at the anode.
9. Do not make any field modifications to your electrofisher without written approval from the manufacturer or a qualified electrical engineer.
10. Use only dip nets with insulated handles.
11. Wear personal flotation devices.
12. Wear lineman's gloves, rated 5,000V minimum.
13. Never reach into the water in vicinity of an electrode, even if rubber gloves are being worn.
14. Take frequent breaks. Stress and fatigue endanger the crew.
15. Practice the quick release system as shown on page C-6.

BOAT SAFETY

1. Ground the generator to the boat hull.
2. Be sure that all the metal parts on the boat are bonded to each other electrically.
3. Run all cables through electrical conduit, or use a heavy-duty rubber-covered cord recommended for wet locations.
4. Make all electrical connections in water-tight junction boxes.
5. Each dip netter should have his own foot switch to control the output. The switch should be wired in series with the emergency off switch of the boat operator.
6. When wading with a boat, even in shallow water, chest waders should be worn. An operator may trip, end up in a kneeling or sitting position in the water and receive a shock.
7. All crew members must be alert. Operators who control the power switch must be constantly aware of the netters in the electrical field.

DO'S AND DON'TS

DO'S:

1. Always be sure that all personnel are clear of the electrodes before turning on the power.
2. Know how to administer first aid treatment for electrical shock.
3. Wear flotation devices.
4. Have electrical circuits checked only by qualified technicians.
5. Disconnect the power supply when the electrofisher is not in use.

DON'TS:

1. Don't electrofish alone!
2. Don't continue to electrofish if your boots or gloves get wet inside.
3. Don't operate an electrofisher if you have had any prior heart ailments.
4. Don't operate generators without covers or screens.
5. Don't operate generators without a spark arrester.

ELECTROFISHING PRINCIPLES

For many years it has been known that fish react to electric current passed through water. Electricity was first used for fishing in 1863 when a British patent was granted. Major efforts to apply electricity as a tool in fisheries management did not occur until after 1950. Since then detailed studies have been made on the physiological effects of electricity on aquatic organisms.

RESPONSE OF FISH TO ELECTRICITY

To collect fish by electrical means we must create an electrified zone of sufficient amplitude to stun fish. In the basic electrofishing circuit, shown in Figure 10, a current is passed between submerged electrodes. A fish between these electrodes forms part of a closed circuit and some current flows through its body.

The effectiveness of the electrofisher is affected by nine factors: voltage, electrode shape, water conductivity, water temperature, conductivity of the stream bed, fish's distance, size, species, and time in the field.

If these environmental factors are too far out of line, poor electrofishing will result. To some extent, the effects of changes in water conductivity may be compensated for by changing the output voltage.

WATER CONDUCTIVITY

The conductivity of the water and that of the fish's flesh are the factors that affect electrofishing most.

The conductivity of water depends on the quantity of dissolved salts and minerals in the water. The conductivity of potable waters in the United States ranges from 20 to 2,000 microSiemens/centimeter. Sufficient current at realistic power levels will flow through water in this range to electrofish successfully.

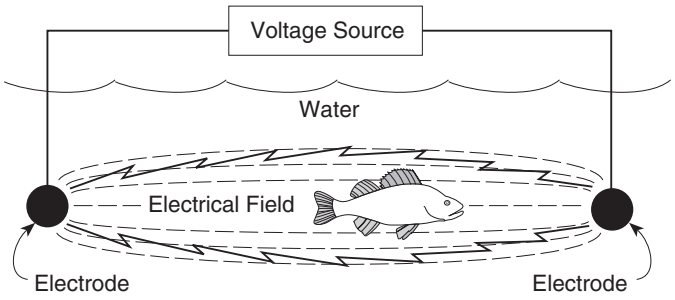
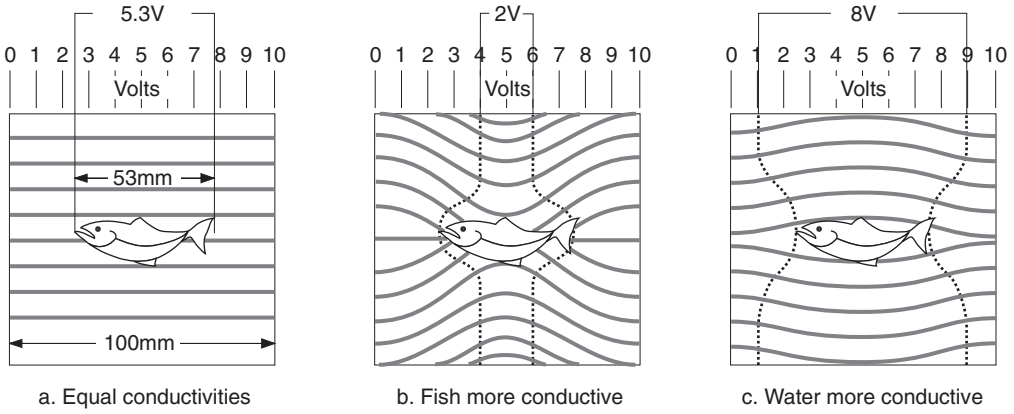


Figure 10. The basic electrofishing circuit.

Figure 11 illustrates the field patterns caused by the presence of a fish in water. In (a) no distortion is caused by the presence of the fish. In low conductivity water, (b), the distortion of the electric field is such that the voltage near the fish is less than it was before the fish was present. The reverse is true in (c) where the water conductivity is more than that of the fish. In this case the distortion is caused by the current concentrating in the water surrounding the fish. In both (b) and (c) not as much power is transferred into the fish's body as in (a).



a. Equal conductivities b. Fish more conductive c. Water more conductive

Figure 11. Electric field patterns caused by fish.

LOW CONDUCTIVITY WATER

Distilled water is a very good insulator. It has a conductivity range of 0.5 to 5.0 microSiemens/cc. If a normal voltage is applied in distilled water, very little current will flow. Power flow is too low to be effective for electrofishing.

The current passing through a fish decreases as the power flow decreases. To get the same response from fish, the current can be maintained by either increasing the voltage, or by keeping the resistance low.

If a higher voltage is used, up to 1,200 volts may be necessary. High voltages create three problems: special electrical equipment is required, safety is reduced for the operators and conditions are lethal for fish close to electrodes.

The resistance can be kept low by increasing the size of the electrodes. The only limitations to this are the availability of larger electrodes, and the weight of electrode that can be handled by the operator.

HIGH CONDUCTIVITY WATER

High conductivity is over 2,000 microSiemens/cc. If a high voltage is applied, most current will flow easily through the water and the fish will hardly be affected. The electric current follows the path of least resistance and bypasses the fish completely. Therefore, use low voltages and high currents. Currents as high as 60 amps are common, the limiting factor being the rating of the power-supply.

Some brackish water and industrial waste water have conductivities over 10,000 microSiemens per centimeter. Here smaller power-supplies are unable to deliver enough power to stun fish. Waters in this range can only be electrofished effectively with the larger model GPPs. The Smith-Root 7.5 GPP outputs 62 amps through 8 gauge stranded cables. This unit can stun large fish in the interface between fresh and salt water. For example, Striped Bass can be stunned for taking brood stock.

Theoretically, high conductivity could be dealt with by using smaller electrodes, but this would reduce the range and also create damaging current densities near the anode.

FISH CONDUCTIVITY

A fish will receive the maximum shock through its body when the conductivity of the water is the same as the conductivity of the fish's flesh. Unfortunately, this is rarely the case.

Fish flesh conductivity ranges from 500 to 1,500 microSiemens per centimeter. Each species has a different conductivity. This affects their susceptibility to electric current.

Conductivities for some fish species are:

Trout	1,220	microSiemens/centimeter
Perch	1,089	microSiemens/centimeter
Carp	870	microSiemens/centimeter
Grudgeon	814	microSiemens/centimeter

E. Halsband - Vilbert 1967

FISH SIZE

Among fish of the same species, the larger fish are more sensitive to electrical currents. Fish absorb power as a function of body surface area. This is important to remember if you are shocking for small fish and large fish are also present. The large fish are going to receive a much greater shock than the small fish.

TEMPERATURE

Water conductivity and effective fish conductivity increase with higher temperature.

Conductivities reported for Carp:

5°	372	microSiemens/centimeter
10°	543	microSiemens/centimeter
15°	714	microSiemens/centimeter
20°	1,026	microSiemens/centimeter
25°	1,969	microSiemens/centimeter

Whitney and Pierce 1957

SUBSTRATE

Certain bottom substrates will conduct electrical current. These weaken the electric field in the water, making fish capture less effective.

ELECTROFISHING BOATS

ADJUSTING THE VOLTAGE

By adjusting the output voltage, the effects of the water's conductivity on electrofishing can be reduced.

The current flowing through the water is directly related to the voltage applied. The higher the voltage, the greater the current will be.

When adjusting the output voltage, the major consideration is the power being used. This is especially true for battery powered electrofishers. Power is equal to the voltage multiplied by the current. When figuring the power for an electrofisher, the fact that it is usually putting out pulsed DC must be taken into consideration. The instantaneous power during a pulse may be quite high, but if the electrofisher is only producing pulses at a 25% duty cycle, the average power would be approximately 25% of the instantaneous power.

FIELD TECHNIQUES

An operator engaged in electrofishing must wade or float, depending upon the depth and swiftness of the water.

WADING

In shallow, slow-moving waters the operators can wade and probe the anode into likely fish habitat. Wading upstream eliminates the effects of turbidity caused by bottom sediment. Furthermore, if collections are for food habitat study, stunned prey are not swept downstream and consumed by predators. Fish that manage to escape are often captured a short distance downstream. Closing a stream with seine nets at each end of the study area helps prevent the loss of stunned and frightened fish.

BOATS

Boat electrofishers are used in lakes and in streams that are too deep or swift to wade. Boats have the advantage of being able to carry large generators and holding tanks for the stunned fish. Electrofishing boats typically have two insulated booms extending from the bow. From the end of the booms electrodes hang into the water. Usually one boom is used as the anode and the other as the cathode. The boat operator guides the boat while the electrofishing crew activates the electrofisher when approaching likely habitat.

NIGHT FISHING

Electrofishing at night with lights is five to ten times more effective than daytime fishing, especially in lakes. In streams the reflection of the spotlight on the ruffled surface makes the fish difficult to see. Boats have floodlights on the bow to attract the fish and to help locate stunned fish.

SURPRISE

Collecting can be enhanced by introducing the element of surprise through intermittent fishing. The intensity of the anode's peripheral field often frightens fish, causing them to bolt and hide. Do not work with the power on continuously, but turn it on only in likely habitats. Fish can be enticed from under areas of heavy cover or ice by inserting a portable anode, turning the power on, and withdrawing the anode slowly and smoothly. Fish will follow the anode, under the influence of galvanotaxis, into the open where they can be netted.

CLARITY AND DEPTH

Clarity of the water limits the ease of capturing fish. The length of the dip net handles and the visibility of the fish limit the depth of effective electrofishing. In general, waters over ten feet deep cannot be sampled effectively. For daytime fishing, polarized sunglasses helps in locating stunned fish.

VEGETATION

Aquatic vegetation grows better from certain substrates and can hinder electrofishing by fouling electrodes and entangling stunned fish.

WATER VELOCITY

Electrofishing in flowing water is not as effective as in still water, since fish are swept away from the electric field and netting is more difficult. Also, it is more difficult to see a fish in fast flowing water, and operators can lose their footing. Flows greater than 5 feet per second usually produce poor electrofishing efficiencies.

REFERENCES

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d) The Consumer will be billed for any parts or labor charges not covered by this limited warranty. The Consumer will be responsible for any expenses related to reinstallation of the Product.
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